PENGUINS OF THE NORTH

With its comical stance and its huge breeding colonies, the guillemot bears a close resemblance to the penguin in both appearance and life-style. Yet the penguin belongs to the Southern Hemisphere, whereas the guillemot is a common British seabird.

Above: A group of guillemots with a pair of razorbills hiding behind. The two species are closely related to each other and occupy the same rocky coastal habitat, though guillemots are much more common.

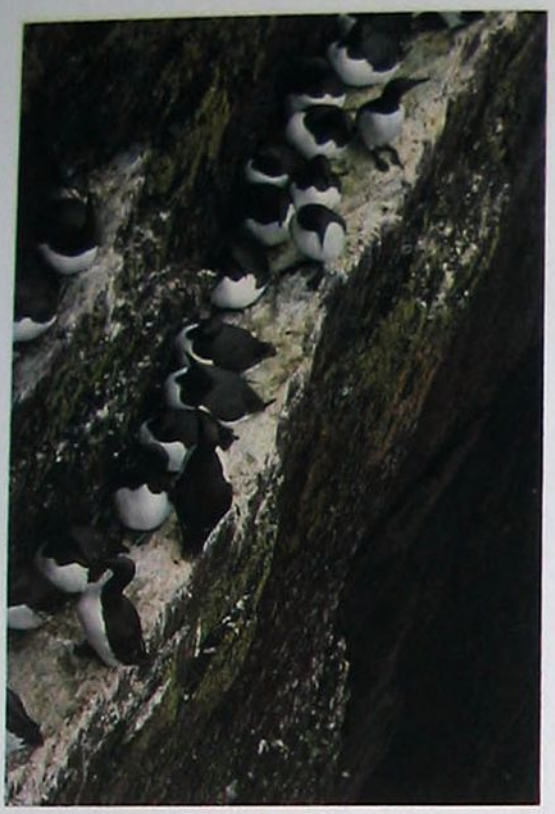
All members of the auk family (of which the guillemot is one) resemble penguins to some degree, even though the two families are quite unrelated; for auks are exclusive to the Northern Hemisphere, just as penguins are to the Southern. The similarities between these two families is due to a well-known phenomenon in which groups of animals that are separated by vast distances but occupy similar ecological niches tend to develop along similar lines. This is known as parallel evolution.

Among auks, it is the guillemot that most closely resembles the penguin; the two species even have a similar anatomy. But the most obvious way in which they resemble each other is in their plumage.

Penguin-like plumage During the breeding season the guillemot's head and upperparts are black or a warm chocolate-brown and the underparts are white. In winter it moults and acquires white cheeks and throat and a grey-brown body.

Occasionally, guillemots show a white eye-ring and a white bar running behind each eye. These 'bridled' birds were once thought to be a separate species, but the phenomenon is now believed to be a plumage phase through which every guillemot passes.

Guillemots in the north of Britain differ somewhat from those found in the south. Their plumage is noticeably darker (almost black) and they are larger – 44cm (18in) long –



Above: A typical breeding ground for guillemots is an inaccessible narrow ledge high up a steep cliff face. Guillemots happily breed on the narrowest of ledges, but the rock must have the right pattern of faults and fractures to give a reasonably horizontal surface, otherwise the eggs could roll off the ledge. Notice the quantity of white guano on the ledges.

Above: The guillemot's wings have become adapted for underwater swimming. Nevertheless, it is still able to fly—unlike its close relative, the penguin, whose wings have become so stiffened and reduced that it is no longer capable of even the shortest flight.

than southern guillemots, which are about 4cm (2in) shorter. Northern guillemots are also more commonly bridled.

Built for swimming The guillemot has a slender, streamlined body, well adapted for swimming under water. Its wings are short and stiff-feathered. Under water, the guillemot uses them as oars to propel itself, but on the surface it swims by means of its webbed feet, which are set well back in its body for the purpose. Inevitably, this makes the guillemot a clumsy, almost comical creature on land and accounts for its penguin-like upright stance.

The guillemot's mainly aquatic life is reflected in its skeletal structure. The backbone is fused into one stiff rod, while the ribs and breastbone are both extremely robust. The ribs also overlap each other to provide extra strength. In this way, the guillemot's vital organs are protected from the tremendous pressures that occur when it dives for food—fish, worms, crustacea and the occasional mollusc.

Below: The staple diet of the guillemot is fish, crustacea and worms. To catch them, the guillemot dives beneath the water and uses its short powerful wings to propel itself along.

Breeding colonies The best time to see guillemots is during the late spring and summer when they are at their breeding colonies on rocky cliffs and stacks of western and northern Britain and Ireland. A typical breeding site is a narrow ledge on a steep cliff-face high above the sea.

The two features of a guillemot colony that strike the visiting birdwatcher most forcibly are the noise and the smell. The noise is hard to describe but resembles something like a continuous rumbling mooing—murres, the American name for guillemots, comes from the noise they make. The smell of a guillemot colony is caused by a mixture of droppings (or guano) and the rotting fishy remains of their meals. The surrounding rocks become whitewashed with guano during the breeding season and make the colony easily visible from a distance.

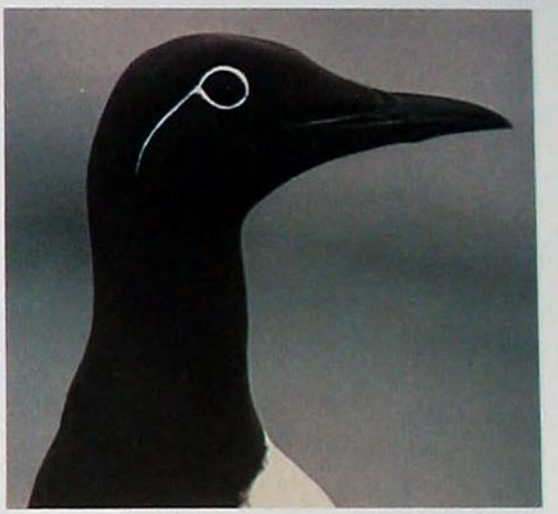
The breeding season During the winter, guillemots spend most of their time in offshore waters, apart from occasional visits to the colony when the weather is fine. But, as spring and the breeding season approaches, these visits become more frequent and longer-lasting.

By the middle or the end of May, the females have begun to lay their eggs. No nest is built—the egg is simply laid on bare rock. Each female lays just a single very large egg, about 8cm (3in) long. Its colour is highly variable, ranging from cream, or pale blue or green, to a reddish-brown, with an enormous variety of dark squiggly patterns on it. Perhaps this variability helps each bird to identify its own egg in the crowded conditions of a guillemot colony. A guillemot's egg is superbly well-designed for survival on a narrow ledge, since it is long and sharply pointed, with straight sides. If knocked it rolls in a tight circle and stays on the ledge, whereas any other bird's egg would roll off the ledge.

The egg is incubated on the open ledge by both parents and takes about a month to hatch. Guillemots are poor parents and often leave their egg unprotected and at the mercy of marauding gulls.

Left: A pair of guillemots shielding their young, possibly from predatory gulls. In crowded breeding colonies the parents perform the same action when feeding their young. They use their wings to protect both the chick and the food, otherwise another young guillemot nearby is likely to jump in and try to steal the food.

Above right: Guillemots in northern Britain and those in the south form two distinct subspecies. Southern birds have a warm chocolate-brown plumage, whereas northern birds are much darker and bigger.



Guillemot (*Uria aalge*). Seabird breeding around rocky coasts of the northern and western British Isles. In winter it extends its range to the east and south coasts. Length: southern subspecies 40cm (16in), northern subspecies 44cm (18in).

A mouthful of fish The young guillemot is born downy and grows rapidly. Both parents help to feed it, giving it one large fish at a time, unlike puffins and razorbills, who feed their young with small fry. When the chick is still young, the fish may be too large for it to take in at one go, in which case an inch or so of the fish's tail is left hanging out of the chick's mouth and gradually vanishes as the the fish is digested.

In a crowded colony the parents have to be careful when handing the fish over to their young or other young guillemots are likely to jump in and steal the food. To prevent this they use their wings as a screen to protect the fish while they pass it to the chick.

A more serious threat to young guillemots is predation from large gulls. To avoid this, they often make for the sea well before they are fully fledged, sometimes when they are only two or three weeks old and half-grown. To reach the sea they have to tumble down the face of the cliff. To us, this seems extremely hazardous, since they are still flightless. The vast majority reach the sea unharmed, however, protected by a thick layer of fat as they bounce off the rocks and, to some degree, supported by the strong upcurrents of air that are always present near a cliff face.

Off for the winter Once at sea the young complete their development in the company of adult guillemots. In the autumn, both they and the adults disperse to spend the winter in the coastal waters of north and west Europe, the Mediterranean and North Africa.

During winter guillemots (not necessarily the same birds as breed here) can be seen at many places along the coast of Britain, not just in the north and west where they breed but also along the coasts of southern and eastern counties. Well-known promontories such as Portland Bill, Beachy Head and Dungeness are excellent places from which to observe them.

The threat from man The guillemot is Britain's most numerous seabird. In 1969, its population was estimated to stand at more than half a million breeding pairs. Over three-quarters of these are to be found in Scotland, with the largest single colony, on Westray in Orkney, having more than 70,000 pairs. Yet the guillemot has long been threatened, both directly and indirectly, by man's activities.

In Victorian times guillemot numbers were seriously affected by egg collectors, especially at sites with large colonies, such as Bempton Cliffs in Yorkshire (now an RSPB reserve).

This century, the major threat to the guillemot has come from oil pollution. At first, this was a threat mainly during the winter when the birds were well out to sea, since that was where most of the pollution occurred. However, with the growth of the North Sea oil industry so close to the guillemot's breeding grounds, the threat has become much greater. If an oil spillage occurred close to its breeding grounds the effect on the guillemot population would be catastrophic; certainly it will be far worse than a spillage far out to sea. So far, however, the guillemot population seems to be stable enough to resist the often thoughtless pressures created by man.

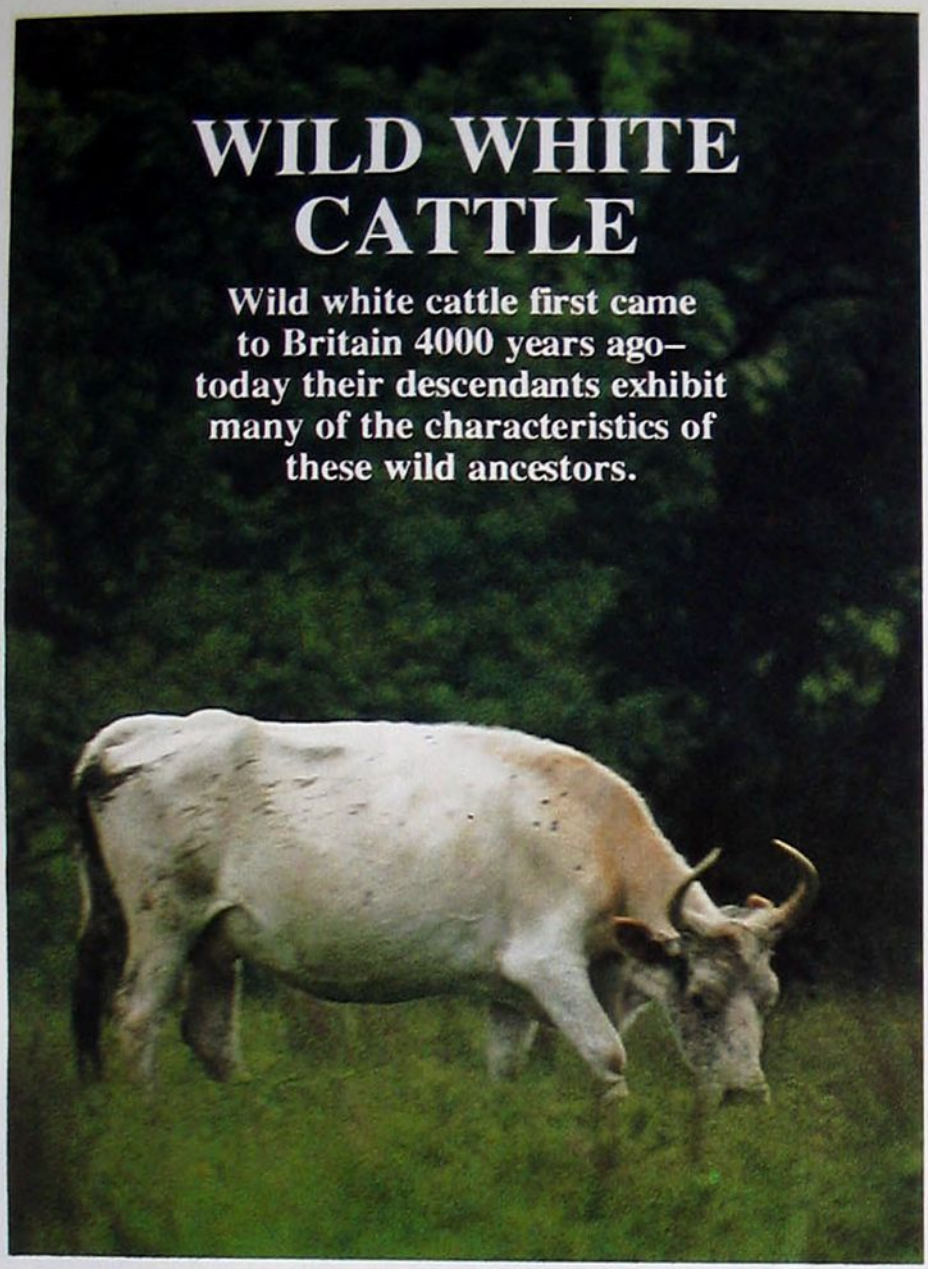
Above: So-called 'bridled' guillemots show a white eye-ring with a white bar running behind each eye. This is believed to be a plumage phase and is more common in northern birds; notice the typically dark plumage of this subspecies.

Egg variations

Guillemot eggs are among the most variable of any bird's. The background colour may vary from white, through buff or brown, to red; or it may be blue or green. The markings may be brown or black dots, blotches or squiggly lines.
Guillemot eggs are long and pointed with straight sides to stop them rolling off into the sea.

WILD WHITE CATTLE

Wild white cattle first came to Britain 4000 years ago– today their descendants exhibit many of the characteristics of these wild ancestors.



Above: The cattle of the Chillingham herd are smaller and less distinctively marked than the domesticated White Park cattle. Their coats are white, their ears are foxy red and splashes of the same colour sometimes extend down the neck. The muzzle is black and the horns are often black-tipped. At times the survival of this unique herd has hung on a thread. On one occasion in the 18th century only three bulls remained in the herd. Two killed each other fighting and the third proved to be infertile. So the future of the herd depended on the chance that some of the pregnant cows would give birth to bull calves. This they duly did.

Cattle were first domesticated over 10,000 years ago, probably in the Near East. It seems likely that most modern breeds of cattle are descended from one wild species, the Aurochs, which is now extinct.

The ancestors of Britain's Wild White cattle were brought over from Spain about 2000BC by the Bronze Age Beaker people. In pre-Christian times these white cattle roamed wild in the forests of northern and western Britain and were used in sacrificial rituals by the Druids. By the Middle Ages they were regularly hunted as beasts of the chase by the king and his court, and in the 13th century several herds were enclosed in noblemens' parks in order to ensure good hunting. Four of these herds are still in existence although only one–the Chillingham herd–still remains in its original park.

White Park cattle, the domesticated version of Wild White cattle, have been used as draught animals and for milking. More recently they have become a valuable beef breed. White Park bulls have been used to produce calves that grow fast and produce a high yield of lean meat.

However, many of the herds in the parks of stately homes are maintained purely for their attractive appearance and their historical interest.

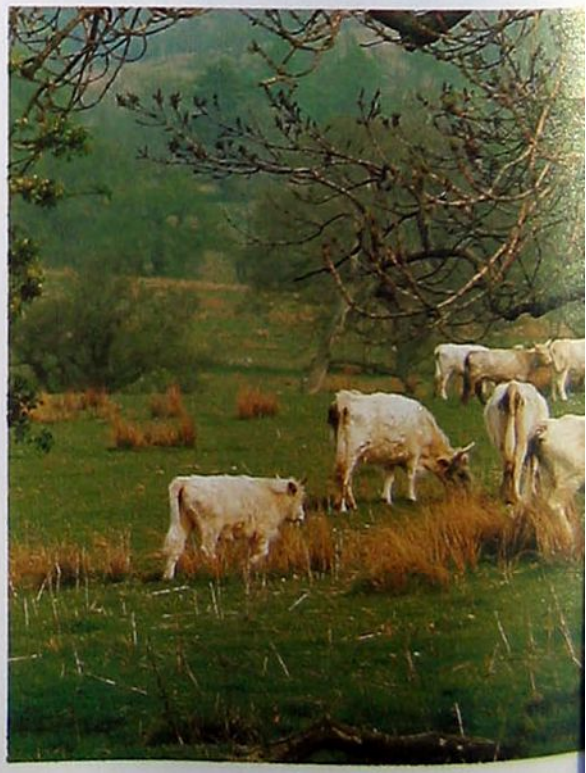
The Chillingham herd Chillingham Park lies in Northumberland, at the southern end of the old Caledonian forest which was once the haunt of the Wild White cattle. The cattle have been confined within Chillingham Park for 700 years. They are only semi-feral but because they are inbred and have had little interference from man, they show many of the characteristics of truly wild cattle. Only the cattle at Chillingham, and those from Vaynol Park in north Wales, can claim to be Wild White cattle; the other white cattle are more correctly described as White Park cattle.

Wild White cattle are hardy animals and can exist on pasture that would be too poor to support domesticated breeds. The Chillingham animals fend for themselves during most of the year but, since the last war when half of the 255 hectares (630 acres) was taken over for agriculture, they have had their diet supplemented in winter by hay and mineral salt licks.

Unlike domestic cattle, the Chillingham animals cannot be handled and will not allow human beings to approach. However, since the park has been opened to the public the cattle have been regularly exposed to human contact and are now less aggressive, although visitors must remain in their vehicles and keep a respectful distance.

The bulls occupy distinct territories within the park. The battles between them are fierce and, although the loser usually flees before serious injury is inflicted, there are several records of bulls being killed while fighting.

After a cow gives birth, she hides her calf



from the herd for eight or nine days, returning to suckle it several times during the day. If the calf feels threatened, by the approach of a human being for example, it flattens itself to the ground like a wild animal. The adults are very protective of the young calves and one or two cows from the herd guard all the calves while the other cows graze. If a calf is handled by a human being, moreover, the rest of the herd will kill it.

The Vaynol herd In 1872 a herd of Wild White cattle was established at Vaynol Park near Bangor in north Wales. It consisted of animals taken from several feral herds in Scotland. Though not as wild as the Chillingham cattle, the Vaynol animals cannot be herded without being tranquilised. They are aggressive, not only to human beings, but also towards each other. When attempts are made to herd them they turn and face their drovers, and charge if further provoked. Recently the Vaynol herd has been transferred to a farm museum in Staffordshire where they can be visited by the public.

Left: The Chillingham herd of Wild White cattle has remained within the confines of Chillingham Park in Northumberland for over 700 years. The park is now open to the public.

Above: The Dynevor herd was kept in the park at Dynevor Castle in Wales until a few years ago when the herd was moved to Northumberland. They now roam the Pennine hill pastures near Hadrian's Wall.

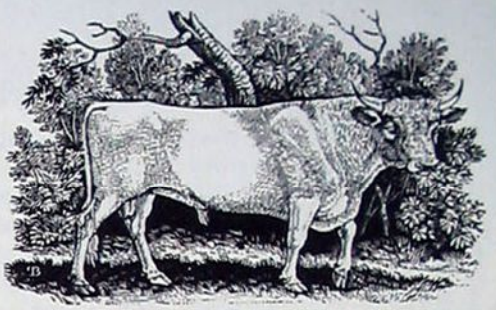
Above: The first record of the Chartley herd refers to their enclosure by Baron Ferrers in Chartley Park in Staffordshire in 1248. They can now be seen at Hedenham Hall in Suffolk and at the National Agricultural Centre, Stoneleigh Park in Warwickshire. These animals are larger and less wild than the Chillingham cattle.

White Park cattle There are several herds of domesticated white cattle. Some of these are of very ancient ancestry but, because of cross-breeding and regular handling by human beings, they have lost many of the wild characteristics of the Wild White cattle. The Cadzow herd is kept on the Duke of Hamilton's estate at Lennoxlove in East Lothian. These animals are bigger and more robust in appearance than the Chillingham animals and have black rather than red markings.

The Dynevor herd, coming from Dynevor Castle in South Wales, were once used as draught animals. They have now been moved to Northumberland. The white cattle from Chartley in Staffordshire were dispersed in 1905 and can now be seen at Hedenham Hall in Suffolk and at the National Agricultural Centre at Stoneleigh in Warwickshire.

Bewick's Chillingham bull

The Wild White bull shown here is from an engraving by Thomas Bewick published in his *History of Quadrupeds* in 1792. He tells us that he could 'make no drawings of The Bull while he, along with the rest of the herd were wheeling about then fronting' him and had to draw instead another bull that had 'been conquered by his Rival and had been driven to seek shelter alone in the quarry holes and woods'. Even then he had to approach with great care.



FLOWERING PLANTS OF WOODLAND SHADE

Plants that grow under woodland trees must be able to tolerate a certain lack of light, although not many flowering species grow in the deepest shade. In early spring, before the new foliage cuts out too much light, those species that prefer damp, shady conditions appear in profusion.

Shade-loving plants find that woodland provides the damp, sheltered conditions they need for growth. In deciduous woodland, the characteristic ground flora consists of plants that flower in early spring while the trees are still bare and the sunlight reaches down to the woodland floor. The most familiar plants in this type of woodland are primroses, violets and wood anemones, which often flower before the leaves open on the trees above them.

The density of shade depends upon the type of woodland; beech trees have leaves that are thick in texture and arranged in a close pattern that allows little light through, while in other mixed broadleaved woodland the shade may be more diffuse. In conifer woods and plantations the shade can be very dense, especially when the trees are mature. Here only ferns, mosses and a few helleborines and orchids can tolerate the lack of light.

Sweet-scented flowers Woodruff is a woodland species that grows on damp, calcareous soils throughout Britain. In some areas it grows in profusion and is welcomed for its fresh growth in early spring. The small flowers, measuring only 5mm in diameter, have dense white petals and form umbellate heads. These are set off by the fresh green leaves which are arranged up the stem of the plant in symmetrical, rather rigid, whorls of six.

Sometimes known as sweet woodruff, this little plant, which is hay-scented when dried, contains the aromatic substance coumarin. In the past, it was gathered and used for strewing on floors in the home, for laying between clean linen and was also added to the stuffing in mattresses. The dried plant was also powdered and dissolved in wine to make a tonic drink known as 'Waldmeister Tea'; and in dried form it is still used today as a pleasant herbal tea.

White woodland carpet Although wood-sorrel–another white-flowered species–grows on shady rocks on mountains in the north and in sheltered hedgerows further south, it is mainly a woodland species. Less than 15cm (6in) high, this early flowering species may carpet the ground in beech woods. It is also found in oakwoods and mixed wood-

Above: **Woody nightshade** (*Solanum dulcamara*). Flowers June-September in woods, hedgerows. Ht 120cm (48in).

Right: In May, the delicate white flowers and clear green leaves of wood sorrel (*Oxalis acetosella*) often carpet the woods.

land, often in the leaf mould at the base of trees or in clefts of tree trunks above the ground. Here pockets of soil may first be colonised by lichens and mosses in which seedlings of small flowering plants can eventually germinate and grow.

The first flowers have distinctive white petals delicately traced with lilac-coloured veins, but they set few seeds, however. Later in the summer there is a second flowering when the flowers are smaller, short-stalked and without petals. These inconspicuous flowers are self-pollinated and set seed in quantity, although wood-sorrel also spreads by means of its creeping underground rhizomes.

The spring flowers nod forward at night or in the rain to keep the pollen dry, and the three leaflets fold back at night. They also stay folded in strong sunlight so that the delicate leaf surfaces do not receive the direct rays of the sun.

Country children often nibble the leaves of the plant; these contain tiny amounts of oxalic acid, which give them a pleasant, sharp taste. In small quantities this does no harm. In fact, in centuries gone by, when winter diets seemed very dull by the end of the season, wood-sorrel leaves were welcomed for their sharpness in spring salads. They were also used to make a green-coloured sauce for which the plant was valued and sometimes cultivated.

Bristly fruits Herb bennet or wood avens, which grows in shady areas, is found throughout Britain as a wayside flower in hedgebanks as well as in woods. The flowers are rather small and few and the soft yellow petals are sometimes partly covered by the green sepals. As the flowers wither, the seeds ripen in a round brown cluster of hairy fruits. Each fruit has a long hooked bristle which catches in fur, feathers or clothing and ensures the dispersal of the seed.

Herb bennet has been known since the Middle Ages, when it was thought to be a blessed herb, its name being taken from the Latin *herba benedicta*. It was once gathered by country people to boil in broth or 'potage' and was grown in gardens for this purpose. The roots have a fragrant, clover-like scent; like the woodruff herb, this 'clove-root' was used to scent linen closets.

Woodland colour The colourful wood crane's-bill also grows in a number of different habitats: on mountains, in meadows and on rock ledges, as well as in hedgerows and woodland. Its Latin name *Geranium sylvaticum*, however, means 'geranium of the woods' and was given to the species by Carl Linnaeus in his classification system of 1730.

In Linnaeus' native Sweden, wood crane's-bill is a common plant of deciduous woodland, while further south in its range it grows away from woods. In the Alps, the deep blue-violet of the paired flowers may often be the dominant colour of the hay pastures.

Above: Woodruff (*Galium odoratum*), seen growing here on a woodland floor dappled with sunlight, can be found in flower as early as April.

In the British Isles, the wood crane's-bill has an unusual distribution pattern, generally widespread and common in Scotland and northern England, but with less than five localities in Wales and Ireland. It has been introduced in a few places in southern

Below: **Green hound's tongue** (*Cynoglossum germanicum*). Flowers June-Aug in woods. Ht 61cm (24in).

Right: **Herb bennet** (*Geum urbanum*). Flowers June-Aug in shade. Ht 45cm (18in).

Some of our most attractive flowers belong to the crane's-bill family, like the wood crane's-bill (above); its distinctive divided leaves and flowers vary from pink to violet in colour. The name crane's-bill is derived from the pointed fruit which is supposed to resemble the long beak of the crane. Wood crane's-bill is in bloom from May to July.

England, but does not occur there as a native wild flower.

Rare species Green hound's tongue is now very scarce in Britain. A plant of woods and hedgerows, it was once widespread throughout central and southern England, but is known now in less than ten localities. The causes for this decline are not fully understood. The species is near the limit of its range here and possibly variations in climate through the years, or changes in woodland management, could have altered the conditions necessary for its growth.

In recent years, trees were felled in woodland where only two or three specimens of green hound's tongue were known and in the following year several hundred of these plants came up in the cleared area. This great abundance of plants shows that the seeds were lying dormant in the soil, waiting for favourable conditions before germinating.

Another, more familiar, species of hound's tongue grows in Britain. This is the common hound's tongue, which has grey leaves felted with hairs. It is found on chalk grassland and dry sandy soils, often near the sea–very different conditions to the damp shade required by the green hound's tongue of the woodland.

Symmetrical structure Herb Paris is another woodland plant that is rare in the British Isles. It has an unusual structure, with the four leaves near the top of the stem arranged in a single whorl, just below the single green star-shaped flower. This flower has four sepals and four narrow petals, with eight thin, pointed yellow stamens. The flower is followed by a single, poisonous black berry, often ringed by the still persistent stamens, petals and sepals.

Found in damp woods on calcareous soils, Herb Paris grows in the south on chalky soil under beech trees, often with Solomon's seal and dog's mercury. In northern woodland on limestone soils it can be found under ash or wych elm trees and it also grows in the crevices of bare limestone pavement. These deep, narrow clefts or grikes produce similar conditions to those of woodland–shade, moisture and shelter; the grikes are therefore colonised by several species of woodland plants.

Colourful climber Woody nightshade or bittersweet is a plant of many different habitats, including shingle beaches and waste ground as well as woods and hedges. Although it grows well in damp, shady woodland conditions, it is not dependent on them and is also found at the edges of woods.

It is a straggling climber, with stems too weak to support the rather heavy heads of flowers and berries. So for support it grows between the stems of shrubs, or in hedges. The flowers are an unusual shape, with a ring of blue petals which fold back as the flower ages, and the yellow stamens are fused together in a forward-pointing cone. The berries are very glossy and green when they first appear, eventually turning yellow and finally red. In early autumn it is occasionally possible to find a spray of berries with all three colours appearing on a plant together in one cluster.

The name bittersweet is derived from the taste of the berries. Due to the presence of a toxic chemical in the plants, they taste bitter at first, and then sweet; and will make you sick if eaten. The plant is sometimes confused with the very poisonous deadly nightshade, which has cherry-sized shining berries, borne singly. When ripe, these are black rather than red and should never be eaten or touched under any circumstances.

Right: Herb Paris (*Paris quadrifolia*) used to be known as the herb of equality or equal parts because it had four petals, four sepals, four leaves and eight stamens. It was believed to be a magical plant, and although the berries are poisonous, they were eaten to guard against witchcraft or the plague. Ritual decreed that they should be taken in odd numbers. However, this theory was counterbalanced by the discovery of 'unequal' specimens of the plant–such as this one–with anything from three to eight leaves.

CABBAGE PATCH VILLAINS

The most familiar of our butterflies are the whites, whose caterpillars are the scourge of every vegetable gardener and the delight of every child with a jam jar.

Above: Mating pair of large white butterflies; the male is the upper individual. Males have fewer markings than females, but this is difficult to see when the butterflies are on the wing.

In Britain we have six resident species of white butterfly and four occasional migrants, all of which fall within the family Pieridae. The three resident species described here are the large white, the small white and the green-veined white.

Although all three are similar-looking on the wing, the small and large whites are distinguished from the green-veined by being known as the 'cabbage whites', because their caterpillars are voracious eaters of cabbage plants. Indeed, due to the economic interest in pest species, these two white butterflies are probably the most intensely studied of all our butterflies.

Eating habits In addition to eating brassica crops, the caterpillars of the large white eat other garden plants that include mustard oils, including nasturtium and mignonette. The small white can also occasionally be found on garden crucifers such as mignonette and arabis. In contrast, the green-veined white does not lay its eggs on cabbage, preferring wild crucifers such as hedge garlic, charlock and cuckoo flower. Researchers assume that before the countryside was sprinkled with juicy hybrid cabbages, the small and large whites must also have fed on various wild crucifers, including our native wild cabbage, hedge mustard and watercress.

Country-wide distribution Large and small whites are common in towns, gardens and agricultural areas, while the green-veined white is their country cousin, frequenting water meadows and uncultivated areas.

Below: Large white butterfly emerging from its pupa.

The difference between the preferred habitats of the small and large whites and the green-veined is best seen in Scotland. There the green-veined white is extensively distributed over the whole country, with cuckoo flower the main foodplant of its caterpillars. The small and large whites are found in towns and small garden plots, this distribution becoming more obvious the further north one goes in Scotland.

Each year our native British populations are reinforced by waves of migrating butterflies from the Continent. All three species described here are common migrants and each year new influxes arrive to swell the numbers.

A double-brooded life cycle As adults, the small and large whites are essentially similar in colour and pattern, the difference lying, not surprisingly, in their relative sizes. The green-veined white is distinct from the other two species in that the veins on the undersides of its wings are sprinkled with fine black scales on a yellow background. In all three species, the males have consistently fewer wing mark-

Above: **Green-veined white** (*Pieris napi*) and caterpillar. Wingspan 36-50mm ($1\frac{1}{2}$-2in).

Above: Small white butterfly uncurling its proboscis to feed. Like most butterflies, it takes nectar from flowers, never eating solid food. Note here the large eyes, furry body and clubbed antennae. When seen close-up, the 'white' wings appear to be faintly speckled.

Left: A communal roost of small white butterflies. Migrants crossing the Channel must rest before they disperse throughout the country. The only way you can tell the difference between this species and the large white is if you have them side by side: then you can see that the small white is, indeed, smaller than the large.

ings than the females.

In an average year, all three species are double-brooded, the first butterflies emerging from March onwards after spending the winter months as chrysalids. These early spring butterflies mate and lay eggs, which give rise to a second brood of butterflies in July. The small and large whites may have a partial third generation in warm years when higher temperatures enable the second brood to develop more quickly than normal and produce a third batch of butterflies in late summer. Many of these will not breed since early frosts would kill off any caterpillars. At high altitudes and in northern Scotland, the green-veined white may have only one brood a year, with the adult butterflies flying in June.

Adult butterflies from spring and summer broods can easily be distinguished on the basis of their wing markings, the spring broods of all three species tending to have much paler markings on their upper sides.

To the casual observer, the sexes are

Predators and parasites: enemies all around

Despite the apparent abundance of cabbage butterflies, they have a difficult time between egg and adult, being assailed on all sides by predators, parasites and disease.

The most obvious killer is the small braconid wasp *Apanteles glomeratus*, which destroys the caterpillar as it is about to change into a chrysalis. Instead of a shiny chrysalis, one finds a mass of bright yellow cocoons (top right) on the dead body of the caterpillar. The female wasp lays her eggs in or on the caterpillar; when they hatch they feed on the caterpillar from inside, only attacking the vital organs when they themselves are ready to emerge and pupate. This type of parasite can account for up to 90% of all caterpillar deaths in some years.

Other important enemies are the tachinid fly *Phryxe vulgaris* and the tiny chalcid wasp *Pteromalus puparum*. The tachinid fly lays its eggs singly on the foodplant or on the outside of the caterpillars of any of the three white butterflies. The fly grub bores into the caterpillar and slowly eats it away from the inside out. The host grows normally and even pupates; but instead of a butterfly emerging, the fly grub bores its way out and falls to the ground to form its own pupa. *Pteromalus*, on the other hand, attacks only the chrysalis stage of the butterfly (below right). A female wasp waits beside a caterpillar changing into a chrysalis, then lays up to a 100 eggs inside it while it is still soft. The eggs hatch into grubs which chew their way out of the chrysalis, emptying it in the process.

White butterfly caterpillars are also attacked by harvestmen, bugs, beetles, birds, spiders, viral diseases and bacterial infections.

Below: **Large white** *(Pieris brassica)* and caterpillar. Wingspan 57-66mm ($2\frac{1}{4}$-$2\frac{1}{2}$in).

Above: **Small white** (*Pieris rapae*). Wingspan 46-55mm ($1\frac{3}{4}$-$2\frac{1}{4}$in).

Left: Green-veined white butterfly feeding on the nectar from a flower. The 'green-veined' appearance is, in fact, an optical illusion: a mixture of fine black scales on a yellow background creates the greenish tinge to which this species owes its name.

Below: Caterpillars of the large white butterfly, with the evidence of their villainous eating habits plain to see. Many gardeners may be horrified to learn that they have little hope of clearing their gardens of such pests. Each year the native British populations are reinforced by migrants from the Continent.

indistinguishable when the butterflies are flying; and even the trained worker has difficulty in telling which species is flying past.

The pestiferous large white The large white is the obvious villain of the cabbage patch, the females laying batches of 100 or more eggs on either side of dozens of cabbage leaves. The caterpillars that hatch feed gregariously until almost full-grown, then split into smaller and smaller groups until each one is feeding alone. This clustering of caterpillars almost invariably denudes entire cabbage plants and draws the attention of the gardener to the conspicuous, evil-smelling yellow and black caterpillars.

When fully grown, the caterpillar wanders off to find a firm base on which to spin a silken mat in preparation for the change into a chrysalis. Once satisfied with a site, it spins a firm base of silk and then winds a single strand of silk around its 'waist' and becomes motionless. After 24 hours or so its skin begins to split down the centre and the glistening chrysalis wriggles into the world. The old caterpillar skin is eventually discarded with a deft flick by the chrysalis while it attaches a series of hooks on its 'tail' to the silken mat.

The chrysalis now becomes immobile, allowing its cuticle to harden and form the mould in which the adult butterfly will develop. This period of immobility may last two weeks or six months, depending on the time of year. Day length is the trigger which determines whether the butterfly will emerge after two weeks or whether the chrysalis will overwinter.

A secretive feeder The small white is a secretive pest of cabbages and is only obvious when holes appear in the leaves. Its eggs are laid singly or in very small groups on the undersides of cabbage leaves, and hatch into small green caterpillars. These feed individually and eventually develop a velvety texture which helps them to hide on the cabbage leaves, their colour and appearance closely mimicking that of the leaves.

When fully grown, the caterpillars crawl away from the plants and seek out a site for the chrysalis in the same manner as the large white. The overwintering chrysalids are usually greyish-brown and well-camouflaged on palings and garden sheds. The summer chrysalids, which are green, are sited on plant stems or even on the cabbages themselves.

The innocent party The green-veined white never lays eggs on any brassica, preferring the wild crucifers already mentioned. Its conical, creamy coloured eggs are laid singly on the underside of leaves and the young caterpillars often conceal themselves along the leaf margin they are eating. The full grown caterpillar is similar to that of the small white and matches the leaves of the foodplant. The chrysalis is formed in the vegetation, often on the stem of the plant on which the caterpillar reached maturity.

MUCH-MALIGNED SHARKS

Despite their man-eating reputation, the majority of sharks – including all those found in British waters – eat nothing more than fishes and crustaceans. In fact, they have more to fear from man, who has caused many species to become rather scarce.

Sharks are living representatives of a group of early fishes known as the cartilaginous fishes. These have been found in fossil form dating back as far as the Middle Devonian period, 400 million years ago. Although often thought of as primitive, they are in fact highly evolved animals, living successfully in a wide range of habitats.

There are some 300 species of shark worldwide, most of which are marine although some live in fresh water for at least part of their life. They are particularly abundant in tropical and warm temperate seas as well as deep seas, but a few occur in polar regions. The Greenland shark, for example, is widespread in the Arctic but rarely visits the coasts of Britain.

Twenty-two species of shark have been recorded in British seas down to a depth of about 1000m (547 fathoms), including such unusually named species as the porbeagle, starry smooth hound, spurdog and tope.

Myth and reality Although vicious, cruel, murderous and man-eating are all adjectives that have been used to describe the shark, none is an accurate description of the sharks to be found in our waters. While it is true that sharks do occasionally attack men, maiming and sometimes killing, the number of occasions on which this has happened is insignificant compared to the number of harmless sharks wantonly killed by man each year.

Sharks have highly developed sensory powers and can detect the presence of a wounded fish from a considerable distance. As they are virtually weightless in water, even the larger species can be very agile when necessary. They do not attack at random among a shoal of fishes when they are looking for prey, but isolate and attack the particular fish they want. The most common constituents of their diet are small prey such as squid and a variety of fishes. Sharks' teeth are perfectly adapted for the type of food they eat, differing in structure from species to species, according to diet.

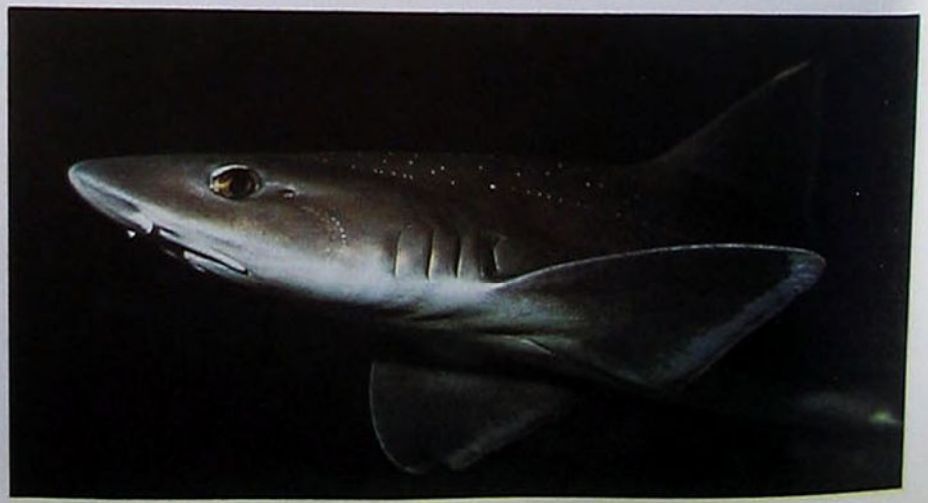
One common factor, however, is the replacement of the teeth in the jaws. Every shark has several complete series or rows of teeth on each jaw, the innermost row being small and still forming in the gums. As the outer teeth break or become loosened, they drop out and are replaced by others formed close behind. One species, the North American lemon shark, is known to lose a tooth every eight days.

Fast feeders A shark's teeth are equally well adapted for the type of food that the species selects. The starry smooth hound, a common British shark, feeds on crabs including the hermit crab, which it crushes together with the adopted whelk shell in which the crab lives. This species has flattened teeth, raised only into slight bumps, and as many as 12 rows are in use at any one time. With its strong jaw muscles and these grinding teeth, this small shark can crush any crab it encounters, reducing its shell to a mass of fragments.

Many of our larger sharks, including such summer-time visitors as the blue shark and the mako, as well as the resident porbeagle and the tope, have pointed triangular teeth with sharp edges. These are ideal for dealing

Above: The sharp double row of teeth in the porbeagle's jaw enable it to grasp and slice prey.

Below: The small, star-like white spots on the starry smooth hound's back give this shark its name.



with soft-bodied prey. The teeth in the upper jaw of the porbeagle have a small extra cusp at the base of each side; those of the lower jaw are similar, but rather oblique. This shape gives them the effect of both a dagger–for stabbing and holding small, actively-swimming prey–and shears, for cutting up the prey. Generally, only two or three rows of teeth are in action at once, but a wide variety of fishes can be taken including herring, mackerel, pilchard, cod, pouting and whiting, as well as squid.

Razor-edged teeth The spurdog and its relatives have cutting teeth that are even more efficient, being triangular or oblique with a razor-sharp edge. The spurdog, which takes its name from the long spine in front of each dorsal fin, is common in shallow water where it feeds on such fishes as herring, sprat, sandeels and whiting. It can literally chop chunks out of its prey. The velvet belly, its deeper-water relative found off the west coast of Britain, has vertical, razor-edged teeth in both jaws. It attacks large fishes, biting a circle of flesh out of their back or sides, which is sometimes found intact inside the shark.

Reproduction Male sharks have a pair of structures called claspers on the inner side of their pelvic fins, which they use to transfer sperm to the female's cloaca. Fertilisation takes place internally in all the species, but there are major differences in the way the young develop.

In some species, such as the shallow water dogfishes, the eggs are protected by a horny case and laid in shallow water. Most sharks, however, retain the fertilised egg within the mother's body and the young are born alive, looking like miniatures of their parents. Live-bearing British sharks include the porbeagle, tope, blue shark (which gives birth rarely in our waters), the smooth hounds and the spurdog.

Advantages and drawbacks Live-bearing clearly offers one major advantage to the young shark, in that it is protected inside its mother; but there are disadvantages as well. The female shark is naturally limited in the number of young she can carry. The maximum litter of the spurdog, for example, is 11 pups, depending on the size and age of the mother. This is very few in comparison with the 350,000 eggs laid by fishes such as the plaice, although of course this number is reduced by a variety of hazards and only a small number may hatch.

A more obvious disadvantage of live-bearing in sharks is the damage caused to population numbers by heavy fishing. Sharks such as the spurdog have gestation periods lasting between 18-22 months; so if the stock is at all heavily fished, large numbers of pregnant females will probably be caught. Population numbers are further limited because many sharks are slow-growing and may not become mature–and thus breed–until they are ten years of age or more.

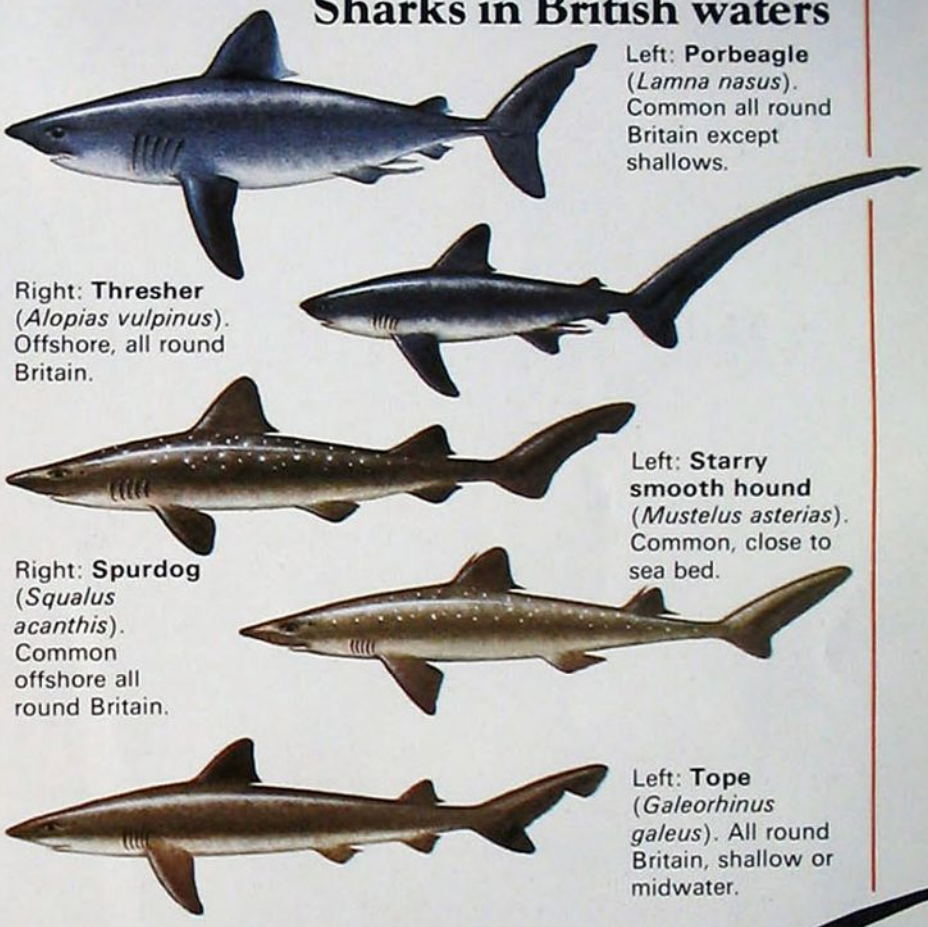
Some facts about sharks

A shark differs from a bony fish in a number of ways. Its skeleton is composed of cartilage, sometimes with a calcium deposit, making it almost as hard as the true bone of a fish's skeleton. Its tail is much more rigid than that of a fish since its backbone extends up the upper lobe of the tail fin.

More obvious visible differences include the 5-7 gill slits found just behind the head on each side of the shark's body, while the gills of a bony fish consist of a single external opening on each side, overlaid by the gill cover. Also, a shark's skin is covered with tiny 'teeth' rather than scales, giving it a smooth appearance but a rough texture if rubbed from tail to head.

Finally, a shark can swim all its life without fatigue and, although it does not possess a swim bladder, it has an enormous oil-filled liver which serves a similar purpose to the swim bladder in other fishes, as well as providing it with a store of food.

Sharks in British waters



Left: **Porbeagle** (*Lamna nasus*). Common all round Britain except shallows.

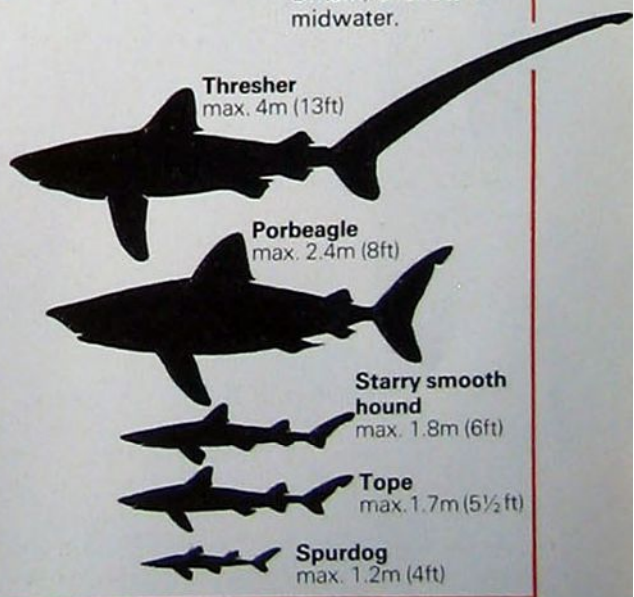
Right: **Thresher** (*Alopias vulpinus*). Offshore, all round Britain.

Left: **Starry smooth hound** (*Mustelus asterias*). Common, close to sea bed.

Right: **Spurdog** (*Squalus acanthis*). Common offshore all round Britain.

Left: **Tope** (*Galeorhinus galeus*). All round Britain, shallow or midwater.

Sharks have a standard body shape–wider at the head and tapering towards the tail. The pectoral fins usually jut out at either side behind the head, but low down on the body. They provide 'lift' for the head end of the shark as it swims forward, propelled by the tail which, if not counteracted, would tend to make the shark nose-dive downwards. The silhouettes (right) show the proportional sizes of the sharks.



GOLDEN CHAINS OF LABURNUM

The spectacular springtime show of yellow flowers gives laburnum its common name of 'golden chains' or 'golden rain'. But the laburnum also has its dark side, for it is one of the most poisonous trees growing in the British Isles.

The three major laburnums (above) differ most noticeably in their flowers. Voss's laburnum (below) is now more widely planted than the other two.

Like so many of the more colourful trees that grow in Britain, the lovely laburnum is not native to this country. It comes from the mountainous areas of central and southern Europe and was familiar to the ancient Romans. Their great naturalist, Pliny the Elder, described it as a 'tree from the Alps, with hard white wood and long yellow flowers which bees will not touch'. He was right that honey bees are not attracted to this tree, because its flowers do not produce nectar. But the wood is not white; the sapwood is butter-yellow and the heartwood is a dark chocolate-brown. Nevertheless, the name laburnum is derived from the Latin for white sapwood.

Species of laburnum From its native countries, laburnum was gradually introduced to the rest of Europe and reached Britain in the latter half of the 16th century. The first laburnum to be introduced to this country was the common laburnum (*Laburnum anagyroides*). This was followed about 30 years later by another species, *Laburnum alpinum*, which was found to grow much better than the common laburnum in the harsher conditions of Scotland. This laburnum is now known as the Scotch laburnum.

A third laburnum, now more widely planted than either of the other two, is Voss's laburnum (*Laburnum* × *watereri*). This is a hybrid between the common and the Scotch laburnum and is in many ways superior to them, particularly in its flowers. It also has a narrower crown, which makes it popular in small gardens.

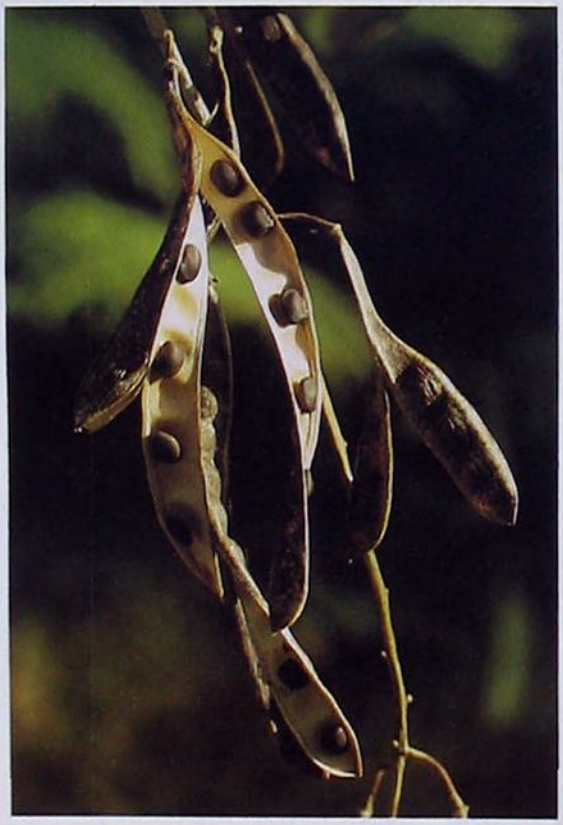
All laburnum species flourish in the British Isles; indeed, they have become adapted to the British climate better than any other introduced tree. Not surprisingly, both the common and the Scotch laburnums became naturalised soon after they were introduced, helped also by the fact that both species set seed abundantly. The best place to see a naturalised laburnum is in wild hilly country.

Similarities and differences Apart from some minor differences, laburnums resemble each other closely. They are small trees, growing no more than 9m (30ft) high–which is why they have long been popular as street trees and for planting in small town gardens. The bark is smooth and olive-green, sometimes turning brown with age. The trunk is slender, seldom exceeding 30cm (1ft) in diameter.

The leaves are unusual in that each consists of three short-stalked leaflets–laburnum is the only tree commonly grown in the British Isles to have this leaf arrangement. The leaflets are up to 8cm (3in) long; their upper surfaces are pale green and smooth, the lower surfaces light-grey and hairy (hairless on the Scotch laburnum).

Laburnum is a member of the pea family and this is shown in the shape of its flowers. These consist of five bright yellow petals arranged in typical pea fashion–one large 'standard' petal, two 'wings' and two more connected to form a 'keel'. The flowers are borne on long pendulous racemes that vary in length from 15cm (6in) to 30cm (1ft). On the Scotch laburnum the racemes are longer than on the common, but they are also narrower and the flowers are more widely spaced. The Scotch laburnum blooms later–around the end of June, which is about three weeks

Above: Like all members of the pea family, the laburnum bears its seeds in pods. The pods, which are borne in clusters, are pale green and hairy when young.



Right: The pods turn brown and lose their hairs as they mature. When ripe they split open, twisting as they do so to force out the seeds. These are brown on the Scotch laburnum, darker brown on Voss's and black on the common laburnum.

Below: The flowers on Voss's laburnum are as densely clustered as they are on the common laburnum but they hang in much longer racemes.

after the common laburnum.

The flowers of Voss's laburnum combine the best features of the other two: its racemes are as long as those of the Scotch laburnum, but the flowers are larger and more densely borne, like those of the common laburnum.

Peas in a pod All plants in the pea family have their fruits borne in pods. In the case of the laburnum, these pods are slender, hairy and light green when immature. They turn brown and lose their hairs as they ripen in July and August.

When the pods are ripe they twist and split along their margins, forcing out the small hard seeds – these are black on the common laburnum and brown on the Scotch laburnum. (One or two seeds at the stalk-end of the pod are often left behind if the twisting action was not strong enough to force them out.) If the tree is growing in the wild this has the advantage of spreading out the interval at which the seeds are distributed, and so increasing the chances of a seed finding conditions favourable for germination.

Deadly poisonous Although the laburnum is widely planted for its beauty it is, nevertheless, an extremely poisonous tree in all its parts – roots, leaves, flowers and seeds. The seeds are particularly poisonous and every year there are cases of young children falling ill after eating them. There are also a few cases of cattle being poisoned after browsing on the pods, though rabbits and hares seem to be unaffected.

The poisonous nature of laburnums is another reason for the popularity of the hybrid Voss's laburnum. As well as having prettier flowers than either of the other two, it produces far fewer seed pods and so attracts children less. The seeds themselves, and other parts of the tree, are just as poisonous as on other laburnums, however.

Two-tone timber Over the centuries laburnum wood has been greatly prized by cabinet makers for its hardness and its contrasting colours. The difference in colour between the sapwood and the heartwood has given rise to what is known in the furniture trade as 'oyster work'. These are small discs or roundels of wood formed by cutting across a laburnum branch to expose concentric rings of growth. The inner rings are chocolate-brown heartwood and the three or four outer rings are butter-yellow sapwood. Laburnum branches can also be cut at an angle to give oval slices. Both sorts of cut are used for decorative inlay work and veneers. Furniture carrying oyster work was particularly popular during the reign of William and Mary; today it fetches a high price at auctions.

Laburnum wood is also ideal for turning work – fruit bowls, egg-cups and so on – since it is hard, close-grained and takes a high polish. Pulleys and blocks made from laburnum last almost for ever, and the chanters on Scottish bagpipes are frequently made from this wood because it can be bored accurately.

In case of poisoning

All parts of the laburnum, especially the seeds, are highly poisonous. Symptoms appear an hour after ingestion. The victim suffers from a burning sensation in the mouth, nausea, severe thirst, abdominal pains, sweating and headache; in severe cases, death follows. Fortunately, it is rare for a child to eat a lethal quantity of seeds (15 to 20). Nevertheless, immediate treatment by a doctor is advisable, even if only one or two have been eaten. Wherever possible, remove any laburnum seeds growing within reach of children.

GRAVEL PITS: A NEW HABITAT

With so many habitats dwindling, it is at least reassuring to know that one industry–gravel extraction–actually creates new ones. After the digging and dredging work is completed, the site is returned to nature, and wildlife takes over.

Gravel occurs naturally in the ground and is dug out to provide materials for road-making and other building work. When the excavation of a gravel pit is completed, the draglines and other machinery are taken away and the open pit usually fills with water. Often this occurs as rain falls and water seeps in from the ground all around the pit; but sometimes the last task of the contractors is to pump water in, to form a lake for amenity purposes. Plants and animals are presented with a brand-new habitat.

This habitat then becomes the scene of a natural process of colonization. If this is to be successful, one important condition is needed: that the pit has gently sloping (not sheer) sides. This ensures that there is a large area of shallow water, which has two advantages for wildlife: it supports prolific water plants, and it also warms up quickly in fine weather. The warmth and the plentiful supply of plants then provide an ideal breeding environment for many species of invertebrates, as well as for frogs and other amphibians. Fishes, too, spawn in the shallows.

First comers Colonization is an ordered process, following the simple but ruthless rules of competition. At first, the strongest competitors in a gravel pit are the algae.

A certain number of these tiny plants–many of them microscopically small–are present in almost any water. Once the pit is filled, they begin to multiply by cell division, thriving on the dissolved nutrients that the water naturally contains.

The higher plants are slower to make their appearance. Seeds are blown in by the wind or brought by birds and animals and, since the water is usually taken from a river, it may already contain fragments of water plants such as pondweeds or water lilies. Both seeds and fragments are capable of developing into whole plants, but their growth is slow, and so it is the advanced algae, known as stoneworts, which are the first rooted plants to become well established. Rooted or free-floating, the algae dominate the pit during the first year.

Often the dense mass of microscopic plants

Below: A gravel pit during the first years after the end of excavation. In the foreground, rose bay willowherb is the most successful among various colonizing plants on the bare gravel. You can also see the low yellow spikes of wild mignonette, the upright stem of teasel and, on the right, a tall-stemmed ragwort with its yellow flowering heads.

Gravel pit birds

Dabbling ducks, such as gadwall and shoveler, feed in shallow water, while diving ducks feed in deeper water. If waterside plants are scarce, mallard, coot and moorhen will not be present, for they seek shelter among reeds and other plants. The vegetation provides nesting sites for great crested grebes. Yellow wagtails may breed on the wasteland of old spoil from the gravel workings. In small, sandy cliffs a few feet high, sand martins make nest holes. As the seasons pass, the increasing variety of plants offers a winter harvest of seed and the winter buds of water lilies and other plants. This is a plentiful food supply for overwintering wildfowl. Pochard, teal, tufted duck, mallard, wigeon and goldeneye are regular winter occupants of mature pits.

gives the water a light green colour. They form a natural light filter that reduces the brightness of the light reaching the deeper water, and therefore its capacity to support life. The seeds or fragments of higher plants, having sunk to the bottom and started to grow their first shoots, are starved of light and can develop no further. So, in the natural contest for a place in the gravel pit, the algae are clear winners of the first round. Their light-filtering effect proves to be a subtle but ruthless means of controlling competitors.

Round two The reign of the algae is, however, short-lived in a gravel pit where shallow water offers a habitat for plentiful aquatic plants. The growth of the algae produces abundant oxygen which enables tiny animals, the zooplankton, to thrive; many of these are plant-eaters, and their feeding checks the prolific growth of the algae.

As the seasons pass, the slow, steady progress of the higher plants takes on a new vigour. Their root stocks, established in the initial phase, produce more shoots. Early growing species, such as Canadian pondweed and water crowfoot, develop rapidly in February and March, extracting quantities of nutrients from the water and leaving less for the spring growth of algae.

With less prolific growth of algae, more light penetrates to the deeper water where most of the higher plants grow. This allows the later-growing plants – water milfoils, pondweeds, hornworts and water lilies – to thrive.

Plant zonation As they appear in the gravel pit, the aquatic plants occupy their range of new habitats in a characteristic pattern. The shallow water up to a depth of 1m (3ft) is suitable for crowfoots and Canadian pondweed. Further out, to a depth of 2m (6ft), are the hornworts, which float beneath the surface. Pondweeds and water lilies grow in water up to 4.5m (14ft) deep, their tall stalks rising from roots in the bottom of the gravel pit. In deeper water still are the water milfoils, which can grow at a depth of up to 6.5m (20ft).

In a steep-sided gravel pit, most of these habitats are either missing or reduced to the narrowest band as the bottom slopes sharply away. Gravel pits of this type tend not to progress beyond the stage of an open pool containing few plants besides algae and perhaps the deep water species.

The marsh plants, too, depend on the habitat offered by shallow water. These are the waterside plants, whose roots can be submerged but can also stand on ground that is dry for part of the year. Soft and hard rushes, or reedmace, soon appear. In succeeding years, a reedbed may grow along the water's edge, leaving room for reedmace only on its outer fringe. Bulrush, and mare's tail, may appear on the outer fringe of the reedbed.

Left: Marsh plants spreading on the margin of Ellingham Lake in Hampshire. Near the water's edge are reed sweetgrass and water dock. Bulrush, which typically grows further from the bank, is seen in the centre of the picture.

Right: A pair of mating damselflies on the emerging flowers of spiked water milfoil.

Below: A great crested grebe sits alert on its nest of rotting vegetation, partly concealed in the invading reedbed.

Arrival of the animals As plant diversity increases, conditions become more favourable for invertebrates. One by one, various species of dragonfly and damselfly, as well as aquatic beetles and other insects, spread to the new habitat. The pace of this invasion slows down as time passes, until the gravel pit has stable plant and animal communities.

After some years, gravel pits are often found to contain fish. Minnows and sticklebacks are common, and bottom-feeding fish such as gudgeon and tench also appear, along with those that feed at all levels in the water, such as roach. Rudd, a plant-eating species, is found, and even pike, which prey on other fish. These species, all coarse fish, colonize the gravel pit naturally, but little is known for certain about how the coarse fish arrive. One possible explanation is that their fertilized eggs may stick to the feathers and feet of wildfowl, and thus travel by air. Game fish, mainly trout, are often artificially introduced to provide sport for anglers.

Frogs and newts colonize gravel pits only where the banks slope gently or where separate shallow pools lie close by. These amphibians depend more than any other group of vertebrates on the warmth and prolific plant growth of the shallow water. Many species of wildfowl come either to rest or to stay for the winter, feasting on the aquatic plants.

Essential variety The community of the gravel pit can only become stable if it has a wide diversity of species. If there are few insect species, any carnivore that lives on them would undergo periods of food shortage. If many species are present, a constant food supply is assured and the community will not lose its carnivorous species.

Some animals that change their diet as

Above: The sedge warbler nests in the base of a reedbed or other waterside vegetation. Its staccato call is often heard in the neighbourhood of a gravel pit.

Left: Spiked water milfoil, an underwater plant with flowers emerging above the surface. There are three British species of water milfoil: alternate-leaved, spiked and whorled. They are capable of growing in deeper water than almost any other water plants, being adapted to survive with a minimum of light.

they grow to maturity are faced with special difficulties in an environment with few species. Fish may feed on bloodworms, water fleas and beetle larvae when young, but as adults they need a supply of larger creatures–water snails, water boatmen, caddis fly larvae and adult beetles. Without these, the fish continue to eat the smaller creatures and deplete the supply; they are then unable to grow to full size, remaining stunted.

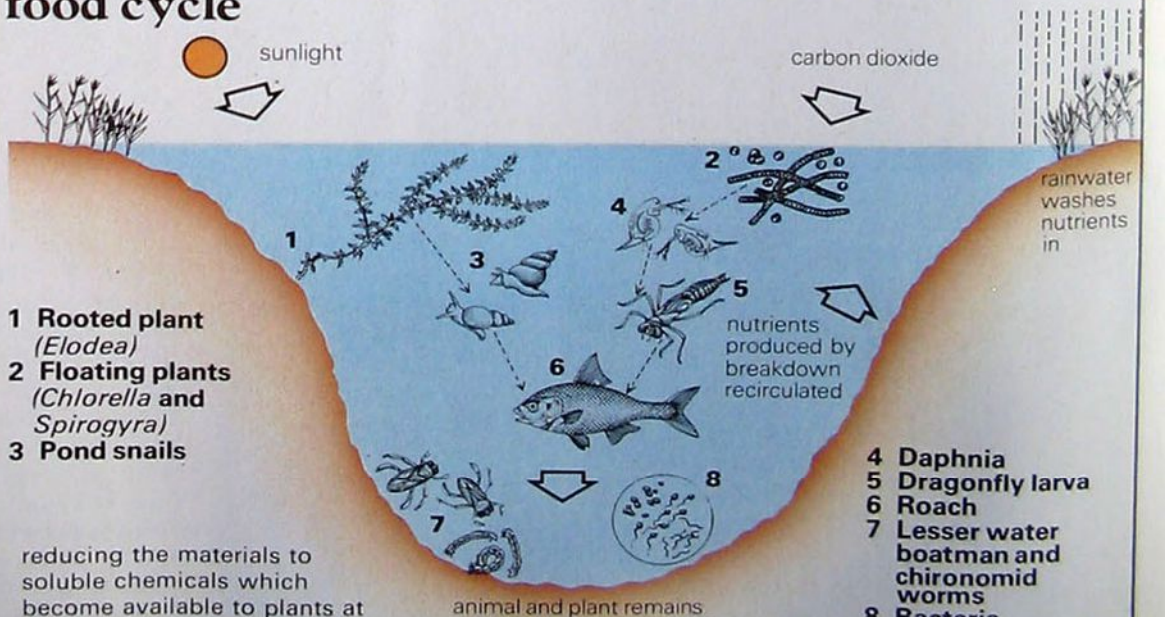
Web of aquatic life In the community that gradually forms in a gravel pit, all the members depend on one another for their survival. Herbivores feed on plants and in turn are the prey of carnivores. Larger or more aggressive carnivores hunt the smaller carnivores, and so the numbers of each species are regulated by the other species that feed on them.

This relationship between a community of organisms is known as a food web. As a gravel pit matures, the water plants form a dense forest beneath the surface. Water fleas clinging to the plants venture out at nightfall to feed on algae, moving upwards towards the surface where the algae are concentrated, and descending in a cloud at dawn to hide among the plants once more. The predators they hide from are minnows, three-spined sticklebacks, insect larvae and young fish.

Eat and be eaten is the rule, and yet even in death nothing is wasted. Uneaten remains of plants and animals rain down and settle on the mud floor, where they are greedily consumed by such insects as the lesser water boatman, whose sucking mouthparts take in the debris like a vacuum cleaner. Mud-dwelling chironomid larvae and bacteria complete the breakdown of tissue into basic chemical compounds. These contain elements such as nitrogen and phosphorus, essential nutrients for plant growth, and so the cycle is complete.

The freshwater food cycle

The food cycle begins when plants manufacture food by absorbing carbon dioxide and nutrients, utilising the energy of sunlight in the process. The nutrients are taken from the mud (**1**) or from the water (**2**). These plants are then grazed on by animals such as snails (**3**) and daphnia (**4**). The herbivores may then be eaten by carnivores such as dragonfly larvae (**5**) and fish (**6**). Thus nutrients pass from the plants through a chain of feeding animals. Plants and animals continually die and decompose. Decomposition is aided by scavenging animals (**7**) as well as by bacteria (**8**), reducing the materials to soluble chemicals which become available to plants at the start of the food cycle.



1 Rooted plant *(Elodea)*
2 Floating plants *(Chlorella* **and** *Spirogyra)*
3 Pond snails
4 Daphnia
5 Dragonfly larva
6 Roach
7 Lesser water boatman and chironomid worms
8 Bacteria

BRITAIN'S EGG-LAYING LIZARD

The sand lizard is unique in Britain, for it is our only lizard to lay eggs. From the middle of April it begins to emerge from hibernation, ready for the new breeding season.

There are only three species of lizard to be found in the British Isles: the slow-worm, the common lizard and the sand lizard. Of the three, the slow-worm is quite distinct since it is limbless and resembles a snake, but the other two, being closely related, are more easily confused.

Telling lizards apart To a practised eye, adult sand lizards are noticeably larger and more heavily built than the common lizard – up to 18cm (7in) long against 15cm (6in) and they are generally pale brown or greyish whereas common lizards are a darker bronzy brown. The two species also have quite different markings, common lizards having a black dorsal stripe which is lacking in sand lizards. Male sand lizards have distinct dark bands and black spots running the full length of their backs. Female sand lizards are more variable but usually have dark brown bands or pale markings on their backs and sides. Many sand lizards, both male and female, have a series of black and white, or brown and white, 'eyes' on their sides or backs.

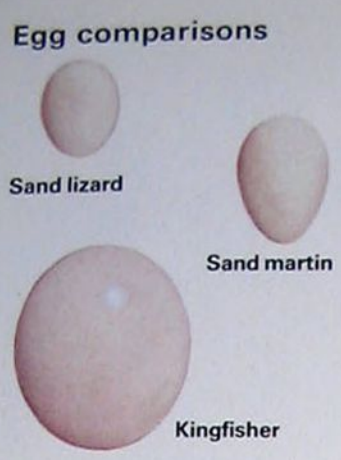
The differences in markings between the male and female sand lizard are usually enough to identify the two sexes, as well as distinguish them from the common lizard. But, in spring, the male sand lizard becomes quite distinct from any other lizard since then its sides turn a brilliant green, almost emerald in colour.

Where to see them Sand lizards occur in many parts of Europe as far north as southern Sweden, though they are absent from Spain and Italy. In Britain, sand lizards have a curious distribution. Most are restricted to parts of Hampshire, Dorset and Surrey, but there is also a small colony to be found near Ainsdale on the Lancashire coast.

The best places to find sand lizards are areas of heathland (either wet or dry), near or among sand dunes, in bracken or scrubland, and on the edges of woodland. Disused railway embankments are popular sites for sand lizards, as are farmland hedges (occasionally even garden hedges) and disused quarries where the vegetation has regenerated itself sufficiently to provide shelter and a

Above: A female sand lizard (*Lacerta agilis*). Despite its name, the sand lizard can be found in a variety of habitats other than sandy heathland or dunes. Disused railway embankments and quarries, hedges and the perimeters of woodland are all good places to observe sand lizards.

Below: Apart from an isolated colony on the Lancashire coast, Britain's population of sand lizards is confined to the southern counties of England.



Above: Sand lizards, sand martins and kingfishers all nest in burrows and lay white eggs. Kingfisher eggs are easy to distinguish since they are large and glossy, but the other two both lay dull white eggs of about the same size; only the shapes are different.

source of food.

Mid-morning on a sunny day in spring is a good time to go looking for sand lizards. This is when they are likely to be basking in the sun, gradually warming up in readiness for the day's hunting. The first indication of its presence is usually a sudden movement as a sand lizard scurries away, but after a few minutes it may slowly re-emerge to continue basking.

Hunting for food Sand lizards feed on insects and other small invertebrates, spiders being their particular favourites. They hunt their food and can easily stalk and capture relatively large spiders and insects.

Some heathlands support only a small population of invertebrates and, consequently, the population of sand lizards is small as well. Other areas with a good variety of plant species, for example, a mixture of heather, scrub, bracken and grass, provide a greater abundance of prey, and so the population of sand lizards is correspondingly larger.

Hibernation Being reptiles, sand lizards are, of course, cold-blooded. That is why they have to bask in the sun each morning, warming up before beginning their activities.

The British winter is far too cold for them to be active, so they hibernate in a hole in a bank, sometimes several sand lizards sharing the same hole. Many have taken to their winter retreats come October, but in a mild autumn, some may still be seen as late in the year as the first week in December.

Emerging for spring Male sand lizards emerge from hibernation in the middle of April, the females appearing ten days after. Both sexes shed their skins soon after emerging, the male developing his bright green spring coat. (Moulting will take place once or twice again later in the year, depending on

Above: A pair of sand lizards mating. During the breeding season the sides of the male's body turn a brilliant green, though its back and tail remain brown. The female remains pale brown throughout the year.

Below left: A group of young sand lizards basking in the sunshine. The young emerge from their burrows in late summer and are pale green or light brown, with tiny white spots. Compared with adult sand lizards, their bodies are much more slender.

Below: Scrubby wasteland is a likely habitat for seeing sand lizards. The best time of the year for observing them is spring, ideally at mid-morning on a sunny day.

how fast the sand lizard is growing.)

Mating occurs during April and May, both sexes showing a variety of postures and movements before actual mating takes place. During this period, males often fight each other, with one male sometimes chasing a rival a great distance.

In June the female begins the exhausting task of selecting a suitable nesting site and digging the burrow. It is not unusual for a female sand lizard to travel up to 100m (110yd) in search of a site and she may begin digging a burrow several times, only to give up part of the way through and begin another one elsewhere. The reason why the female is so particular is that the eggs require just the right conditions if they are to incubate successfully–they require warmth but must not become too dry. Yet the female is not present during incubation to ensure that these conditions are maintained. A recent study has shown that most burrows are dug in sites where the eggs will be in contact with fine living roots from the surface vegetation. It seems that they have a better chance of hatching if this is so.

The burrow is usually dug in a small area of bare ground, though the site chosen may also be completely surrounded by heather or even tall grass. The female sand lizard's sharp claws enable her to burrow easily to a depth of 8cm (3in), in either sand, soft soil or clay.

Eggs and young Either five or six eggs are laid in the middle of July. Considering the small size of the adult female, the eggs are surprisingly large–about 15mm (§in) long. Once they are laid, the female covers them with sand or soil and then abandons them. The incubation period is between 55 and 70 days; by the middle of August or September the process is complete and the newly hatched lizards dig their way to the surface. At this time of year young sand lizards can be seen basking in family groups near their burrow.

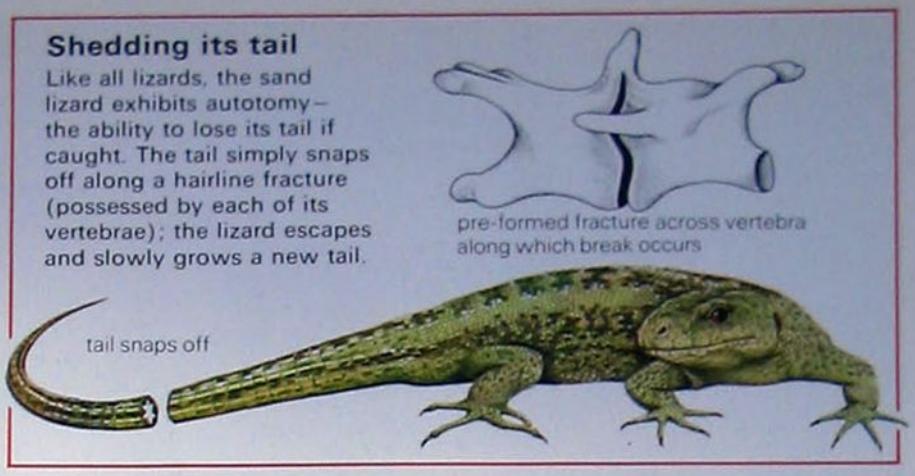
Recently used burrows can be identified by their crescent-shaped entrance or by a shallow depression in the ground, about 8cm (3in) wide, through which the young lizards escaped. It is most important that these empty nests are not disturbed because there may well be other nests close by with unhatched eggs.

Young sand lizards are pale green or light brown, with white spots on their bodies serving to distinguish them from the adults. Compared with adults, the young have slender bodies and relatively large heads.

Declining numbers Britain's population of sand lizards has been declining for some years. This is partly due to the sand lizard's practice of laying eggs rather than giving birth to live young, for the eggs are vulnerable to more than just the caprices of nature. Eggs laid on the edges of well-used tracks are easily disturbed by people, horses, dogs or wild animals, and there is also the danger of predation from mammals such as rats, mice, voles and even foxes. The common lizard and the slow-worm avoid these problems. They give their eggs a controlled environment by carrying them around inside their bodies, and hatch live young.

A more serious threat to the sand lizard is the destruction of its habitat as man encroaches upon heathland and scrubland. This is why the sand lizard has such a fragmented distribution nowadays.

Fortunately, nature reserves have now been established to provide suitable habitats, and the sand lizard has been declared a protected species, so the future of Britain's only egg-laying lizard seems to be secure.



Right: The sand lizard has to face many hazards from man, including the problem of litter. Discarded bottles act as a trap to a small animal such as the sand lizard, which can easily crawl inside but then cannot get out again because the glass sides are too slippery for the animal to get any purchase on them. The animal slowly dies inside the bottle.

Above: A female sand lizard adopting a defensive posture. If attacked by a predator, such as a snake, a sand lizard becomes quite ferocious, biting and thrashing around to avoid being eaten.

Black mustard (*Sinapis nigra*). Flowers May to August on sea cliffs, roadsides, streamsides, apart from N Ireland and N Scotland. Ht up to 1m (39in).

White mustard (*Sinapis alba*). Flowers May to August on cultivated and waste ground, especially chalky soils. Ht up to 80cm (31in).

Treacle mustard (*Erysimum cheiranthoides*). Flowers June to August on cultivated and waste ground. Ht up to 90cm (35in).

Annual wall rocket (*Diplotaxis muralis*). Flowers May to September on cultivated and waste ground, walls and limestone rocks. Ht up to 40cm (16in).

Gold-of-pleasure (*Camelina sativa*). Flowers June to July on cultivated and waste ground. Rare. Ht up to 80cm (31in).

GOLDEN FLOWERS OF SUMMER

The fields of gold that you see in summer are produced by the yellow-flowered members of the Cruciferae family. They are not restricted to arable land–these colourful species can be found in a variety of places, from sea cliffs to waste ground.

Above: Winter cress (*Barbarea vulgaris*), seen growing here on a disused railway line, is also known as yellow rocket because of its tall flower spikes, which grow up to 75cm (30in) high. The bright yellow flowers are in bloom from May to August; after they have faded away, the plant remains green throughout the winter.

The Cruciferae family is more uniform in appearance than many other families of flowering plants. All its members are herbaceous, with spirally arranged leaves and small, four-petalled flowers arranged in racemose (spike-like) inflorescences. The fruits of the family are unique in structure–being specialised capsules called siliquas if long and thin, and siliculas if short and fat.

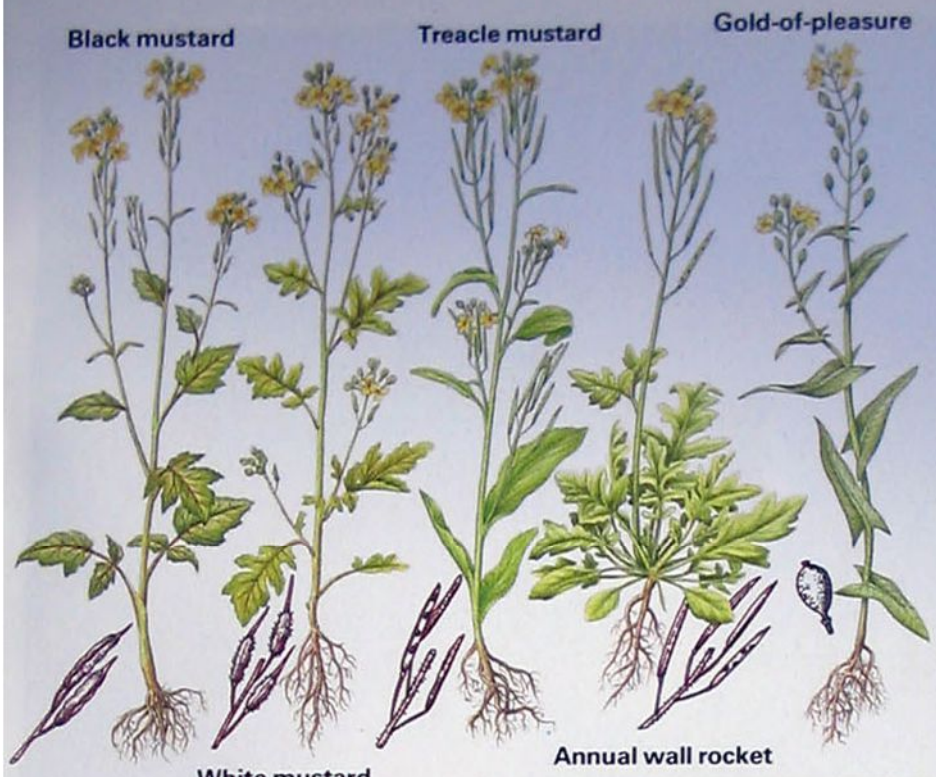
The majority of the species within the family have either white or yellow flowers, although a few have lilac flowers. Several of the yellow-flowered species belong to the genus *Brassica*, which has given us such important vegetables as cabbages, cauliflowers, Brussels sprouts, swedes and turnips.

Food plants The probable ancestor of all these *Brassica* vegetables is the wild cabbage, which now grows in only a few places in the British Isles. It is an annual or biennial plant with fleshy blue-green leaves and pale lemon-yellow flowers which are often produced throughout the summer. The young leaves are tender and edible, although with rather a hot flavour, but the older ones are tough, as is the base of the stalk. This becomes woody, just as it does in cultivated varieties, a relatively rare occurrence in crucifers.

Two other members of the crucifer family –the black and white mustards–are still important to man for food purposes. Both plants are annuals and grow wild in all parts of Britain. The native black mustard flourishes on sea-cliffs and stream banks as well as in waste places, while the introduced white mustard thrives on arable land and waste ground, particularly on calcareous soils.

Confusingly, both species have yellow flowers, those of black mustard smelling of coumarin (a haylike smell) and those of white mustard smelling of vanilla. They can best be distinguished from one another by their different coloured seeds; the seeds of black mustard are black, while those of white mustard are yellowish-brown.

The seeds are the only part of the plant used in food manufacture. White mustard seeds are ground to a powder and then mixed with water, vinegar, pepper, tartaric acid and



spices to form the familiar table mustard which is eaten with meat. The seeds of black mustard are either ground, or used whole as in Dijon mustard–a powerful condiment made with whole seeds mixed with vinegar, spices and white wine. The name 'mustard' comes from the 13th century method of making the condiment when the seeds were mixed with partially fermented grape juice known as 'must'.

Confusing crucifers Two crucifers sometimes confused with each other are wild mustard (more commonly known as charlock) and wild radish. Charlock is almost entirely confined to arable land and cornfields, its flowers colouring fields bright yellow from April to July. Wild radish is also found on arable land, although it favours acid soils. Its flowers can be very variable in colour; the most common form has yellow petals with dark purple veins, but there is also a white-flowered variety growing in southern England; another variety has lilac, purple-veined flowers and a Scottish variety has plain yellow petals.

Like the mustards, these species are easier to distinguish when they are in fruit. The siliqua of charlock splits open to release a row of seeds, while the long, thin silicula of the wild radish is quite distinctive. Each seed is contained within its own separate portion in the pod. When the pod is ripe, it breaks up into its separate portions.

Brightly coloured weeds Treacle mustard is another yellow-flowered cruciferous weed that grows on light, cultivated soils, mostly in southern England. It was probably introduced into this country from Europe in the 15th century, when the seeds were used in medicines to cure intestinal worms; hence it is sometimes known as the wormseed mustard.

The plant is an annual and, although not common in Britain, it is found in increasing numbers, probably because it has a high rate of seed production and so is able to colonize new areas quite rapidly.

The attractively named gold-of-pleasure, on the other hand, has never been common in Britain. Its flower stalks, bearing many small yellow flowers, may be seen in June or July along roadsides or on cultivated land, particularly in fields of lucerne or flax.

The wall rocket is another cruciferous weed of arable and waste land. An introduced species, it is often found with the perennial wall rocket, which is probably native.

Another native perennial, winter-cress, provides patches of bright colour in wet places such as damp hedgerows and streamsides all over Britain, as well as on waste ground. Its shiny green leaves are still conspicuous during the winter months, and in the past they were eaten in salads. Their taste is slightly bitter, however, and water cress is now more commonly used instead.

Above: Charlock (*Sinapis arvensis*) often forms seas of golden yellow in the summer fields. However, it is not welcomed by the farmer as it is a troublesome weed, housing and feeding many pests. Modern selective herbicides have been so effective in controlling this plant that it may soon become extinct.

Right: Woad (*Isatis tinctoria*) is another species that was once common but is now rare. This is due to decreasing use rather than to agricultural changes. Once widely grown for the blue dye that could be extracted from its yellowing leaves after fermentation, it is perhaps most famous for its use as a war paint by the Ancient Britons.

Above: A stone curlew nesting among sand dunes. In the British Isles its main natural habitat is heathland, where stony and sandy places abound.

A VOICE CRYING IN THE WILDERNESS

The stone curlew is a rare bird, visiting our heaths, fields and other open spaces from spring to autumn. It is highly skilled at concealing itself, but at night it makes its presence known by a strange assortment of shrieking calls that carry far across the countryside.

The stone curlew is one of the strangest birds to breed in Britain. Although classified as a wader, it is never associated with water, instead being adapted to live in deserts. In fact it is found in the dry, sandy and stony areas of Europe, North Africa and Asia, and Britain is at the extreme north-western edge of the stone curlew's range. In the British Isles the bird is rare, around 300 pairs being present in an average breeding season.

The name of the stone curlew is derived from its basic call which, like that of the curlew, is a long 'coor-li' sound. This far-carrying sound is highly suitable for a bird that lives in wide, open spaces such as heaths or indeed deserts. Apart from having a similar call and sharing a liking for open spaces, the stone curlew and the curlew have little else in common, and are not related.

The thick-knee The stone curlew is distinctive in its general appearance, though not in the colour of its plumage, which is sandy brown and adapted for camouflage. It has enormous, pale yellow eyes (an adaptation for nocturnal life) and long, thick legs, also pale yellow in colour. The thickness of the legs is reflected in the local name given to the stone curlew in Norfolk – the thick-knee. In flight the bird shows a double wing-bar unlike any other species found in the British Isles, although when it is on the

Below: The present distribution of the stone curlew. In the past, the species used to breed in most parts of southern England, East Anglia and Lincolnshire, and in parts of Yorkshire.

ground only one of the wing-bars is visible. In the field, stone curlews are very difficult indeed to see, for their coloration is so like that of the sandy soils of the heathland and arable land they inhabit. Besides, they are always on the look-out and seldom allow an observer to approach closely on foot. At the first sign of man's presence, they generally run away in a typically crouched attitude to some hidden ground where they may either take off and fly away, or crouch in a hollow, completely hidden from sight.

Noises in the night The stone curlew, then, is not a bird that is easily or frequently spotted in our countryside. At night, however, its call may be heard, and this is perhaps the most thrilling aspect of the species. This bird of the wide open spaces has an impressive range of weird and spine-chilling calls, quite unlike those of any other British land-bird. Its usual call, the long 'coor-li' sound, is mixed with repeated 'yikkering' noises and unearthly screams as the birds defend their territories and communicate with each other. On a still night, they may easily be heard more than a mile away and sometimes even twice as far. In Dorset the calls were once believed to be the sound of the souls of hanged criminals calling to one another from the gibbets on Dorset's heaths.

Breeding time Stone curlews have been recorded on a few occasions in Britain during the winter months, but it seems very unlikely that any winter with us regularly. Most seem to winter in northern Africa or Spain, the earliest birds returning during March. The breeding birds are generally settled by April, when the two-egg clutch is laid in a simple hollow or scrape. The scrapes are usually excavated just below the crest of a slight ridge, so that the incubating bird does not show against the skyline, but has a good field of view in all directions.

The eggs are large and brown, with darker flecks, and were at one time much prized by egg collectors because of the variation they showed. After hatching, the young are fed by their parents for the first few days on worms and other invertebrates, which they find on the surface of the soil or just beneath it. A parent often runs 60 or 70 metres to feed a chick with something which it has just found. At this stage the young are mostly kept close to some form of cover where they can hide if danger threatens. Later, as they grow, the chicks try feeding themselves, pecking at anything that might be a food item until they learn to recognise what is good to eat. Generally both parents stay with them until they are able to fend for themselves and to fly – five weeks or more after hatching.

There are a few records of new nests being built and clutches laid as late as July. Some of these are late replacements for broods that have been lost, but others are second broods. The chicks of such a late brood become fully independent during September.

Dwindling numbers Past records show that stone curlews used to be more numerous than they are today. At their autumn gatherings before migration in October, old records show tallies of 30, 40 and even 50 birds; in recent years numbers have seldom been as high as 20. They are now rare birds in Britain (specially protected by law) and their breeding range seems to be contracting year by year. Within the main areas of their range they fare relatively well, and detailed studies have shown good breeding success. It is the more isolated habitats, where perhaps a few pairs used to breed regularly, that have seen the greatest fall in numbers.

It used to be thought that the reclamation

Stone curlew (*Burhinus oedicnemus*). Summer visitor; nests in April and departs in October for France and then southern Europe and North Africa. 40cm (16in) in length, distinguished by bold white wing bars, yellow eyes and thick yellow legs.

Below: A stone curlew tidies the nest after the first chick has hatched. Incubation takes about 26 days and the young are mobile within a day or so of hatching.

Above: A warning display: the stone curlew holds up its wings in a threatening posture to defend its territory from an intruder.

Left: A stone curlew utters its call. In daytime, the bird does not normally make its more unusual calls.

Below right: Disused arable land provides a favourable nest site. Originally the stone curlew inhabited the open scenery of wolds, downs and heaths; much of this land has been converted to farmland, but the stone curlew still manages to breed in some areas of arable farmland.

of heathland for agriculture was the reason for this decline. Certainly this change in the countryside has affected the stone curlew, for over the decades large areas of heathland, the bird's main natural habitat in Britain, have been brought under cultivation. However, as the wild habitat was cleared, the arable land which replaced it has served the stone curlew almost as well. There are healthy populations breeding in areas of arable land, particularly in parts of East Anglia where hardly any heathland remains.

Another factor has been the fall in the rabbit population in the early 1950s, when myxomatosis was introduced. Stone curlews usually make their nests on a small patch of bare ground. Rabbits, which dig open the turf, are natural providers of such nesting sites, so their decline was a serious loss for the stone curlews.

Favourable factors In some parts of the British Isles, for example Surrey, Hampshire and Dorset, secure populations of stone curlews live in small islands of natural heath in areas where 80% of the land is cultivated. Landowners often wish to preserve this mix of heath and arable land so as to allow game birds to breed for sport. However, should game shooting decline as a sport or bring less income to the landowner, these areas would also be at risk.

In the areas of arable land where stone curlews breed, the exact nature of farming operations is the decisive factor in their success. In the past, fields with sugar-beet were often the most suitable for the species, because no mechanical operations used to be involved. The seedlings were thinned out by hand, and labourers would naturally take care not to harm nests as they worked. Now beet is sown with pelleted seed, so that thinning (or 'singling') is no longer done; and instead of hand tilling, mechanical hoeing is usual, the tractors and machinery used posing a grave threat to the nesting birds.

Field beans or kale are the safest crops for stone curlews today, for they are not tilled mechanically. Even in machine-cultivated crops, farm workers who are concerned to save birds can take care to find the nests and protect them from harm: so with sympathetic management, the birds can breed successfully whatever the crop.

One rather surprising ally of the stone curlew is the Army. Many of the birds nest in areas used for military training, for these include a number of sizeable tracts of heathland. Tanks leave stretches of bare ground which are useful nesting places; and the Army is an excellent protection agency as it keeps disturbance by members of the public to a minimum. Provided they do not get run over by a tank, birds in these areas are generally in a fortunate position. Possibly a fifth of the British breeding population now nests on Army land.

SEEING THROUGH MANY EYES

Most insects have eyes, but they are often only fully developed in the adults. Insects use their eyes just as we do, but their structure and mode of working is very different.

Insects use their eyes, just as other animals do, to see their way about, to recognise members of their own species, and to identify their enemies and sources of food. Unlike us, however, they have two distinct kinds of eyes, which are often present together in the same individual. The simpler sort of eye is called an ocellus and has a single lens. In the other kind, the compound or faceted eye, there are numerous lenses, sometimes many thousands.

Simple eyes In its simplest form an ocellus consists of a convex lens with a transparent layer underneath it. Below this are light-sensitive cells grouped in little bundles called retinulae.

Simple eyes are developed in two distinct situations. They are present on the sides of the head of some larvae of the more highly evolved insects. The caterpillars of butterflies and moths usually have groups of six ocelli, but sawfly larvae have just one on each side of the head. These are the only eyes that larvae have; they can detect movement and light intensity but are capable of very little more than this.

In most adult insects there is, in addition to a pair of compound eyes, a group of three ocelli on top of the head. Their presence is puzzling, but they are thought to be stimulatory organs that help to increase the speed of the insects' reaction to light. More research is needed to discover their exact use.

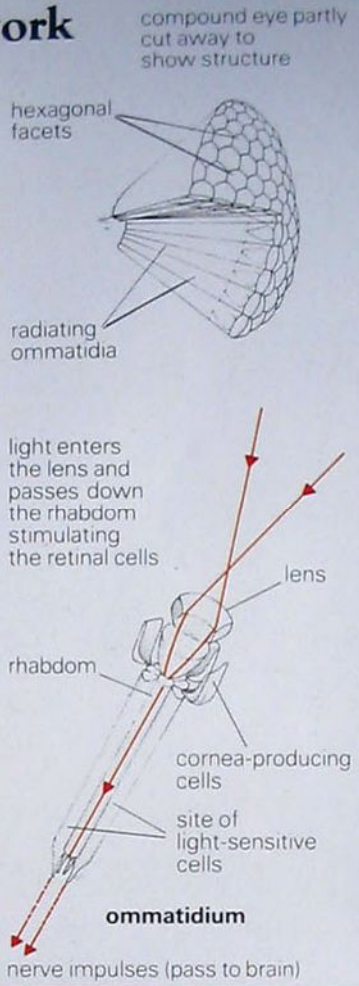
Most adult insects have compound eyes. Butterflies, like the pearl-bordered fritillary (above), have good colour vision, but it is not known whether all insects are similarly equipped. The eye of an elephant hawkmoth (below left) is specially pigmented to give it the appearance of having a pupil. This may serve to frighten away predators. The horsefly's large, iridescent eyes (below right) are efficient at locating movement.

How compound eyes work

The compound eye has an external transparent layer – the cornea – divided into hexagonal facets. Each facet is the outer part of a visual structure called an ommatidium. This has the form of a long narrow cone tapering towards its inner end. The cones are all in contact with each other and usually number several thousand. The eye, therefore, consists of a bundle of numerous, precisely arranged, radiating ommatidia. Each one has a small hexagon of cornea on the outside, with a group of four transparent cone cells below; together these make the lens system. Under the cone cells is a long retinal rod or rhabdom, surrounded by a bundle of elongated retinal cells; these comprise the retinula or light-sensitive part of the eye. The rhabdom probably contains the light-sensitive chemical which stimulates the retinal cells. The cones and retinulae are surrounded by a layer of dark pigment which visually isolates each ommatidium from the next.

In the compound eye light is focused by the cornea and cone cells on to the outer end of the rhabdom-retinula bundle. Although this combination of lenses forms an image, it seems that the insect does not appreciate this, but rather the amount of light collected by the ommatidium. The precise radial arrangement of the ommatidia ensures that every point in the insect's visual field is covered by an ommatidium. Light intensity from the insect's surroundings is thus resolved into an even pattern of points.

An ommatidium has a very limited field of view. It makes its own image and sends its own signal to the brain, so that the insect sees a 'mosaic' made up of many small images. The picture is not sharp, but the compound eye is efficient at detecting movement.



Above: Close-up of a fly's eyes. The thousands of ommatidia each send a signal to the brain, forming a 'mosaic' image.

Below: A dragonfly's eyes are so large and bulging that it can see practically all around itself. Each eye has about 28,000 ommatidia, which means that the insect can recognise shapes quite well. It can see movements up to 12m (40ft) away.

Night versus day sight There is an interesting specialisation involving the dark pigment layer surrounding the cones and retinulae. In some night-flying insects this pigment is absent, so light 'leaks' from one ommatidium to the next.

The presence of the pigment, which isolates each ommatidium, gives better image formation, but much of the available light is absorbed by the pigment and virtually wasted. Where there is no pigment the insect resolves images less clearly but has better night vision since the light is not absorbed. Some insects, including the nocturnal moths, have it both ways. In the dark their ommatidia permit the passage of light, but daylight causes pigment to move up between the ommatidia to form isolating sheaths like those in the daylight-seeing type of eye.

Good and bad sight Large eyes with numerous ommatidia give the best appreciation of images. The largest and most highly developed of all insect eyes are found in dragonflies, which need efficient eyes because they hunt at speed on the wing. Each dragonfly eye may contain as many as 28,000 ommatidia.

It is in detecting movement that compound eyes are at their best. Horseflies have large eyes and use them to locate the animals on whose blood they feed; they even sometimes mistakenly pursue moving vehicles. Hoverflies use their eyes in a different way. They are able to hover in one place in air that is constantly moving and eddying about. It seems likely that they do this by visually 'locking' themselves on to nearby objects that shift relatively with every movement of the fly, and the insect, like a helicopter pilot, makes an automatic correction every time it is blown slightly out of position.

Insects that live mainly underground may have very poorly developed compound eyes.

Some worker ants, for instance, have only a dozen or less ommatidia in each eye and their eyes then hardly function as compound organs.

Colour vision Some insects certainly have colour vision. This has been demonstrated in experiments with bees. Little transparent saucers are placed on an arrangement of coloured squares, one on each square. One saucer is filled with an odourless sugar solution, and all the others with water. After a time bees locate the one with sugar and gather to feed at it. If they are allowed to feed for some time and then the saucers are rearranged, they continue to visit the one on the colour that they associate with food, even though it only contains water.

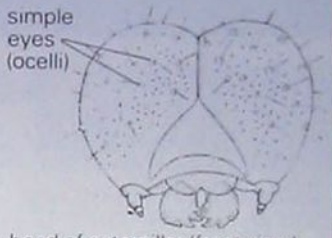
Butterflies also have good colour vision. Their eyes are particularly sensitive to blue and they fly down to investigate artificial flowers of this colour. Peacock butterflies, bred in captivity, have been trained to feed from test tubes filled with a honey and water solution. If the tubes are provided with paper collars shaped roughly like a flower and coloured blue or purple, the butterflies find them far more quickly and visit them more frequently. Butterflies also recognise their mates by their coloration, and can be deceived by paper models.

In the course of experiments on insect vision, it has been found that most of them do not see as far into the red end of the spectrum as we do. In fact they are colour-blind to red but, to compensate for this, they are sensitive to radiation beyond the violet end – they can see ultraviolet which, although it is a normal component of sunlight, is invisible to us. There are certain species of flowers, including celandine, evening primrose, silverweed and members of the Compositae like fleabane and ragwort, that appear plain yellow to our eyes. But, if they are photographed in untraviolet light they show a distinct black or deep blue pattern. Most show a black 'bull's eye' with a blue surround, but the evening primrose shows a pattern of black streaks converging on the centre. The blue part reflects ultraviolet light, while the black part absorbs it. The pattern, clearly visible to insects, is obviously there as a guide to the centre of the flowers where the nectar is to be found. There could be no better indication than this that the colours of flowers have evolved with, and are addressed to, insects.

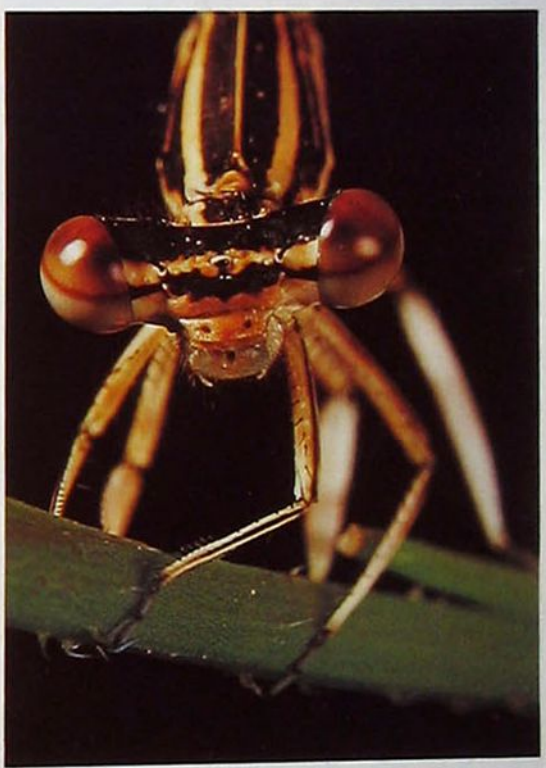
Many kinds of butterfly, especially the yellow species of the family Pieridae, have ultraviolet patterns on their wings. These are revealed to us by photography of mounted specimens, but in sunlight butterflies can see them just as well as we see the colours that are within our own visible spectrum. The male of the brimstone butterfly, in particular, has brilliant ultraviolet 'coloration'.

True and false eyes

A caterpillar often looks as though it has two big staring eyes on its head. The elephant hawkmoth caterpillar (left) is a typical example. In fact, these 'eyes' are no more than special body markings designed to frighten away predators. The only eyes a caterpillar has are several ocelli or simple eyes (below) which can detect movement and light intensity but little more.



head of caterpillar (front view)



Right: On the head of this damselfly you can see not only the two enormous bulging compound eyes on each side but also two tiny, shining ocelli or simple eyes in the centre. It is difficult to account for the presence of the simple eyes, but they are probably stimulatory organs.

Below: An evening primrose flower photographed in daylight (left) and also in ultraviolet light (right). Under ultraviolet light a distinct pattern of dark streaks leading to the centre of the flower shows up. Insects which, unlike man, can see ultraviolet, are guided by the pattern to the centre of the flower where the nectar is hidden.

SWEET BAY: POET'S LAUREL

Few plants are surrounded by as much mythology and symbolism as the sweet bay. Though not native to Britain, the sweet bay has been grown in this country for centuries and is the source of one of our most popular herbs: the bay leaf.

Sweet bay (*Laurus nobilis*). Evergreen shrub or small tree, native to the Mediterranean. Naturalised in some parts of southern England, but more often seen as a garden shrub (see below). Height to 15m (50ft) but usually smaller.

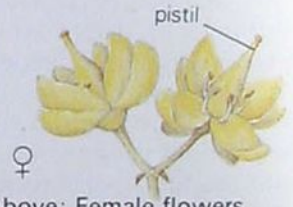
Common names are often an unreliable guide to whether plants are related to each other. For example, the sweet chestnut and the horse chestnut sound as if they should be closely related–but they are not. They are related only in so far as both are broad-leaved trees but, because their nuts are similar, they were long ago both called chestnuts.

The same situation exists with the word 'laurel'. True laurels are members of the laurel family (Lauraceae) but the term has been indiscriminately applied to a wide range of broad-leaved evergreen shrubs, so that we now have the cherry laurel, which is related to cherry trees, and the spurge laurel, which is actually a species of *Daphne*. There is only one true species of the laurel family commonly grown in Britain and that is the shrub (or small tree) known variously as bay, sweet bay, bay laurel or poet's laurel.

Northern outlier Sweet bay is one of the few members of the laurel family to grow well in the British Isles. Most are native to the warm temperate or tropical zones. For example, the most economically important member of this family, the avocado pear, comes from Central America.

The sweet bay is native to the Mediterranean region and has been cultivated in the British Isles since about the 16th century, or possibly earlier. It is moderately hardy in this country, apart from in the far north-east, and has become naturalised in parts of southern

Above: Male flowers are pale yellow and consist of four petals and four sepals surrounding about a dozen stamens.



Above: Female flowers resemble the males closely, the only difference being that the petals and sepals surround a single pistil.

Above: Bay leaves with immature fruit. The leaves have wavy margins and a parchment-like texture.

England. However, it is usually seen as a bush growing in gardens, though it is also common as a potted plant.

Sweet-smelling leaves The part of the sweet bay most familiar to people is the leaves. These are, of course, the well-known bay leaves, one of our most popular kitchen herbs. They have a distinctly sweet smell (hence the description 'sweet' in the name sweet bay). Bay leaves are used either fresh or dried for flavouring a variety of dishes, especially stews and soups.

The leaves of sweet bay are evergreen and persist on the plant for two or three years. They have an oddly stiff, yet brittle texture, rather like parchment. The upper surface is slightly glossy and mid-green to dark green, except along the midrib and other veins, which are pale and translucent – if a bay leaf is held up to the light the delicate network of veins shows up clearly. The leaf margins appear toothed at first sight but, in fact, they are simply crinkled and wavy.

Sweet bay occasionally has just a single stem but more often it has several and is shrubby. The bark is very dark, almost black, and generally smooth or slightly wrinkled, though it may become cracked near the base.

Segregation of the sexes The male and female flowers of sweet bay are borne on separate trees. They appear in clusters in the leaf axils on the previous year's wood. Each cluster contains between two and five individual flowers, which open in the spring to reveal four pale yellow petals. In the case of male flowers, these surround a dozen stamens; on female flowers they surround a single pistil.

Usually just one female flower in each cluster develops into a fruit. This is a small round or oval berry, which is green when young but becomes black or dark brown and wrinkled by the time it reaches maturity during winter. When mature, bay berries are about 10mm ($\frac{1}{2}$in) long. The word 'bay' comes from the French word for berry, 'baie'.

In common with all other true laurels, the sweet bay undergoes what is known as hypogeal germination. All flowering plants have one or two leaves present in embryonic form inside the seed. These are the cotyledons, or seed leaves, and are usually the first leaves to appear above the ground when the seed germinates. In hypogeal germination, however, the cotyledons stay inside the seed below ground. When a sweet bay seed germinates, it sends up a narrow shoot above ground, from which emerge true leaves which are scale-like at first but soon grow to resemble the adult leaves.

Myths and legends Man has long held the sweet bay in special regard. The ancient Greeks knew the tree as Daphne because, in their mythology, it was believed that the nymph Daphne turned into a bay tree to escape from Apollo, the Greek god of music, poetry and healing. In remembrance of the nymph, Apollo declared the bay to be sacred to himself and symbolic of his own attributes.

Above: Bay berries are green when young but darken as they mature. By the time they ripen in the winter, they are black and wrinkled. The berries are borne in the leaf axils, usually just one to an axil.

Right: In June, sweet bay bears clusters of pale yellow flowers, between two and five appearing in each leaf axil on last year's wood. Male and female flowers are borne on separate plants; close examination is needed to tell the sex of a flower and therefore of a particular bush. These flowers bear clusters of stamens and so are males.

With the decline of ancient Greece and the ascendancy of the Roman Empire, bay's traditional associations were transferred to Rome. The Romans called sweet bay 'laurus', from which the modern word laurel derives. They used to award both their conquering warriors and their poets with laurel, the former being crowned with laurel leaves and the latter being presented with branches of laurel in fruit (the modern position of Poet Laureate originates in this ancient custom).

The association of laurel with honour and glory has continued ever since. Napoleon incorporated a golden spray of laurel foliage into his crown; there is the expression 'to rest on one's laurels'; and the modern word 'bachelor' derives from the latin 'bacca-laureus', meaning laurel berry. Originally, the word bachelor referred to one who studied, as in Bachelor of Arts and so on. But, because students used to lead a monastic life and did not marry (and were male), the word came to mean an unmarried man.

Potted bay trees
Bay makes an ideal pot plant since it is one of the few evergreen plants that can withstand having its roots confined in a tub. Potted bay trees, perhaps clipped into an unusual shape, are often seen decorating the entrances of smarter restaurants.

AN INTRODUCTION TO WHALES

Whales and dolphins spend all their lives in the sea–feeding, playing, mating, giving birth to their young and migrating in the great oceans of the world. Many species, including the huge blue whale, have been seen in British waters.

Above: This southern right whale (*Eubalaena australis*) has its mouth open, displaying the hornlike baleen plates which hang down from each side of the upper jaw. The inside edge of each plate is covered with bristles. The whale sucks in water and plankton (small plant and animal organisms) then strains the water out through the baleen plates, using its massive tongue to push the water out. The plankton gets caught on the baleen and is swallowed.

Superficially whales resemble some of the large shanks, but certain features clearly identify them as mammals–they are warm-blooded, breathe air with lungs, and give birth to living young that are suckled on milk secreted by the mammary glands of the mother.

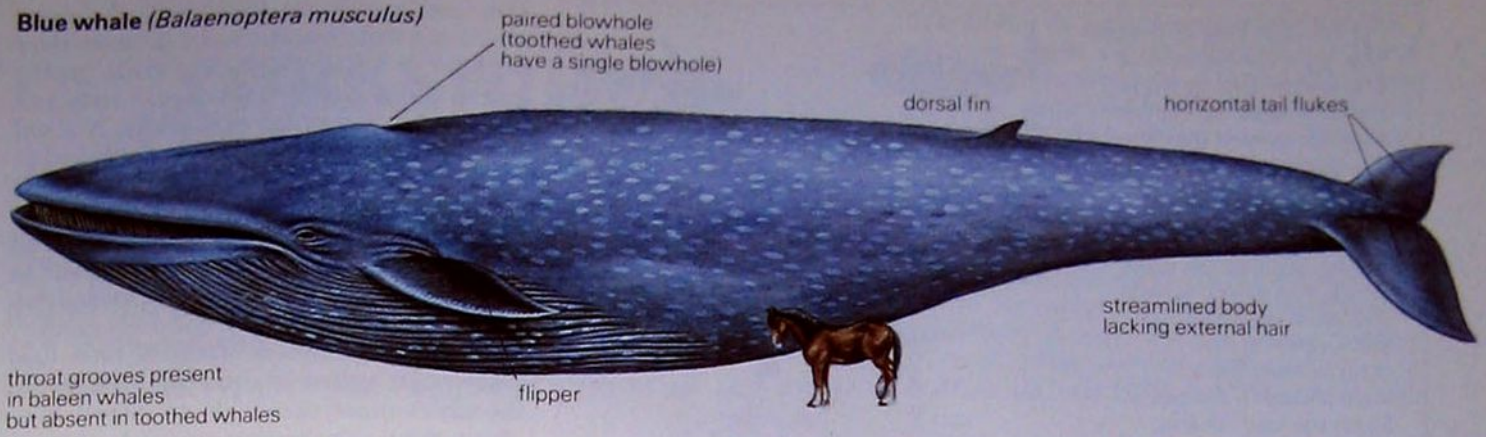
Two groups of whales There are approximately 80 species of whales and dolphins, all belonging to the order Cetacea. Of these, 86% belong to the sub-order Odontoceti, the toothed whales; the rest belong to the Mysticeti, the whalebone or baleen whales.

The most obvious difference between these two groups of whales is their feeding apparatus. The Odontoceti have teeth, although in some they are not visible as they do not emerge through the gum. The toothed whales feed mainly on fish and squid, which they pursue and capture with their teeth. The killer whales, however, may also eat the flesh of penguins, seals and dolphins.

Another feature of toothed whales is that the arrangement of bones in their skulls is asymmetrical and consequently there is only one external opening, or blowhole. The nasal passages either unite close to the blowhole or one is suppressed, leaving the other as the sole breathing tube.

Among the Odontoceti are the small whales we call dolphins and porpoises, which usually measure only 1.5-4m (5-12ft) in length. There are also some larger toothed whales, such as the 18m (60ft) sperm whale, and the killer whales, beaked whales and pilot whales, all measuring between 4-9m (12-30ft) in length. Also included in the Odontoceti, but rather distinct, are the river dolphins, thought to be the most primitive cetaceans now living.

The other group of whales is the Mysticeti. Instead of teeth the members of this group have a system of horny 'plates' (called baleen and also known as whalebone) with which they filter or strain planktonic organisms from the sea. Plankton forms most, and in a few cases all, of their diet. The skulls of the Mysticeti are symmetrical and they have two blowholes. Most of the Mysticeti are large



whales. There are three main groups: the rorquals, which includes the blue whale (the world's largest animal) and the distinctive humpback whale; the right whales; and the grey whale.

The largest animal on earth How is it that animals the size of whales can have evolved? The answer lies in the fact that they live in water. Water provides support for the enormous body, which on land would require limbs so large that mobility would be very restricted, and the animal would be in danger of seriously injuring itself if it should fall.

Despite their size and weight, whales and dolphins are very mobile. This is because, in the course of evolution, they have evolved a streamlined body which is the ideal shape for moving through water. The head has become elongated compared to other mammals, and passes imperceptibly into the trunk with no obvious neck or shoulders. The body has two horizontal fins called flippers and tapers to a boneless tail fluke. In many species there is also an upright dorsal fin. There is no special nose structure, the nostrils opening by a single or double blowhole on the top of the head.

Further streamlining has been achieved by reducing protruding parts that would impede the even flow of water over the body. The hind limbs have been lost, although there are still traces of the bony skeleton within the body. There are no external ears–just two minute openings on the side of the head which lead directly to the organs of hearing. In order to maintain the body's smooth shape, the male's penis is completely hidden within muscular folds, and the teats of the female are hidden within slits on either side of the genital area.

Keeping warm Like all mammals, whales are warm-blooded animals. However, unlike most land mammals they do not have a hairy covering to keep them warm. Hair or fur would be an impediment in water: it would become waterlogged and heavy and would then chill the animal rather than keep it warm. The whale's answer to this problem is a thick insulating layer of fat, called blubber, immediately beneath the skin. This layer of blubber is another very obvious difference between cetaceans and land animals.

How do whales move? Whales drive themselves through the water using their powerful tails, but unlike fishes which move their tails from side to side, whales move their tails up and down. The upward stroke provides the propulsion and the downward stroke is passive. Most cetaceans have a well defined dorsal fin which is assumed to have a stabilising effect.

The fore limbs have a skeletal structure similar to that of the human arm but they have been modified to form paddle-like flippers which are used for steering.

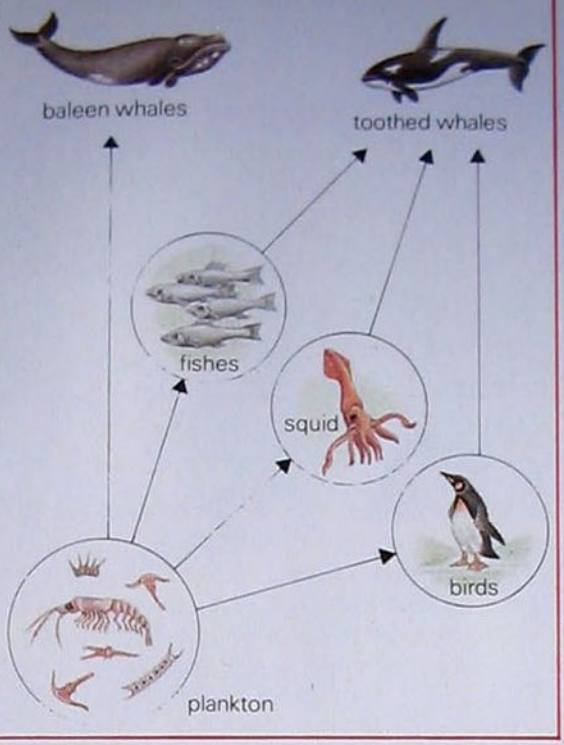
The problem of breathing Cetaceans spend most of their life under water, some of it at considerable depths. Because they are mammals they breathe air direct, instead of extracting oxygen dissolved in water as fishes do. Whales must therefore return to the surface at regular intervals to take air, and when they dive they must hold their breath. Because of their unique physiology whales can hold their breath for lengths of time

Above: One of the most striking features of the Cetacea is the enormous size of some of their species. The blue whale is the largest animal that has ever lived and can reach 30m (100ft) in length and weigh up to 150 tonnes, 150 times the weight of our largest mammal–the Shire horse.

Below: This group of southern right whales is engaged in an energetic mating chase. They are found in the southern oceans and in the northern hemisphere are replaced by the closely related *E. glacialis* which some people consider to be a different race of the same species.

Food for big mouths

The huge concentrations of plankton that occur in the polar seas during the summer months provide the food for many animals – fishes, squid, seals and seabirds as well as cetaceans. Baleen whales such as the right whale, humpback whale and the blue whale eat krill – a shrimp-like plankton that lives in huge shoals in the sea. Some toothed whales, such as the sperm whale, eat squid, while others, including most dolphins and porpoises, feed mainly on fish. The killer whale may also feed on penguins and other warm-blooded animals – even the blue whale.



that seem improbable; for instance, the sperm whale can remain under water for more than an hour at a time. When the whale returns to the surface its blowhole opens wide and the foul air is expelled explosively. A cloud of steam, known as the spout, is produced as the moisture in the warm breath condenses on coming into contact with the cooler air. This is known as 'blowing' and occurs in all whales, although the spout is less visible in smaller species. As soon as the animal has exhaled it takes in more air and dives again.

How do whales see? There is little light deep under water so cetaceans rely mainly on senses other than sight to inform them about their surroundings and help them to locate food. They have a very highly developed sense of hearing, and communicate with each other by making a variety of sounds.

The toothed whales, which pursue fast-moving fish and squid, locate their prey by using sonar. The whale emits intense, short pulses of sound in the ultrasonic range. These clicks, and other sounds, bounce off objects in their path producing echoes from which the whale is able to build up a sound picture of its surroundings. The whalebone whales have not yet been shown to use echolocation and may instead rely on sight to locate the dense swarms of plankton on which they feed.

Family life The gestation period in whales varies from species to species, but is usually about 12 months. The single young is born head first and is immediately nosed to the surface by its mother so that it can breathe. The young whale is able to swim at birth. Its mother's milk is rich in protein so the calf grows quickly. Maternal care is well developed in all cetaceans and the calf is dependent on its mother for many months, in some cases for a year or more. Maturity is reached after a relatively long period.

Above: The killer whale (*Orcinus orca*) is one of the larger toothed whales; adult males reaching 9m (30ft) in length. It is a handsome animal with three large splashes of cream on the body. It has a tall dorsal fin which may be up to 1.8m (6ft) high in the male. The two rows of sharp teeth are clearly visible.

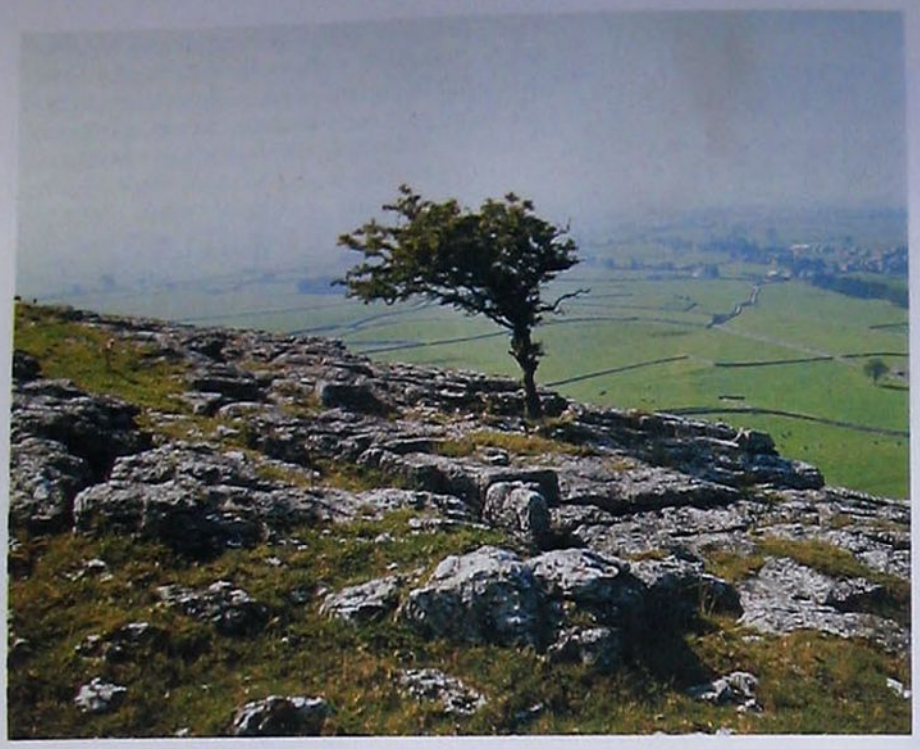
Right: Common dolphins (*Delphinus delphis*) are found throughout the world in waters that are not colder than 15°C (59°F). They seem to enjoy playing around ships and are often seen riding in the wave at the bow.

YORKSHIRE'S DALES COUNTRY

There is a wilderness character about much of the Dales country, created by the cloudy, rainy weather and the tracts of high, seldom-visited land that lie between the dales. The view (below) of West Stonesdale typifies the rugged grandeur of the area.

The Yorkshire Dales are set among the Pennines. Some 60 valleys lie within the Dales National Park area, and of them half a dozen are large and well-known. These are Swaledale, Wensleydale, Wharfedale, Dentdale, North Ribblesdale and Airedale. Between the dales themselves lie large areas of high country where, in a score of places, the fells overtop the 610m (2000ft) contour. The Pennines present a formidable north-south barrier to the westerly gales. As a result cloudy conditions prevail, and rainfall is heavy–1778mm (70in) of rain falls each year at Ribblehead, and 1473mm (58in) at Malham Tarn.

Though winter in the upper dales is long,



with a late spring and a cool and cloudy summer, there are clear, sunny days on which this area is revealed as one of the most attractive in England. A visitor to the high ground sees a succession of ridges, with the dales tucked between them. Upland plateaux are whitened by the downy heads of cotton-grass (actually a sedge); a cliff at Malham Cove, forming part of Britain's largest outcrop of limestone, gleams chalk-white against a blue-black storm cloud and, after evening rain, its damp surface glows a delicate pink as it catches the rays of the setting sun; and on dry ridges, and across half the landscape to the east, the heather blooms in late summer, to be followed in late autumn by the colourful tints of dying bracken fronds. With few trees in view on the top of the fells (apart from the new plantations of sitka spruce), the landscape can also often look stark and empty, however.

The geology of the dales For a ready guide to the local geology of the area, take a look at the drystone walls – thousands of miles of walls made without a dab of mortar. The builders of these walls did not believe in carrying rocks too far, and thus their walls faithfully reflect the underlying strata.

The dominant stratum is Carboniferous, with the beds tilting towards the east and showing the succession of rocks: Carboniferous limestone (in places hundreds of feet thick); the Yoredale Series (bands of limestone, shales and sandstones, lying above the Great Scar Limestone); and Millstone Grit (coarse sandstone deposited in the delta of an ancient river which provide a virtually impervious cap to the isolated western hills and which are the dominant rocks to be seen in the east).

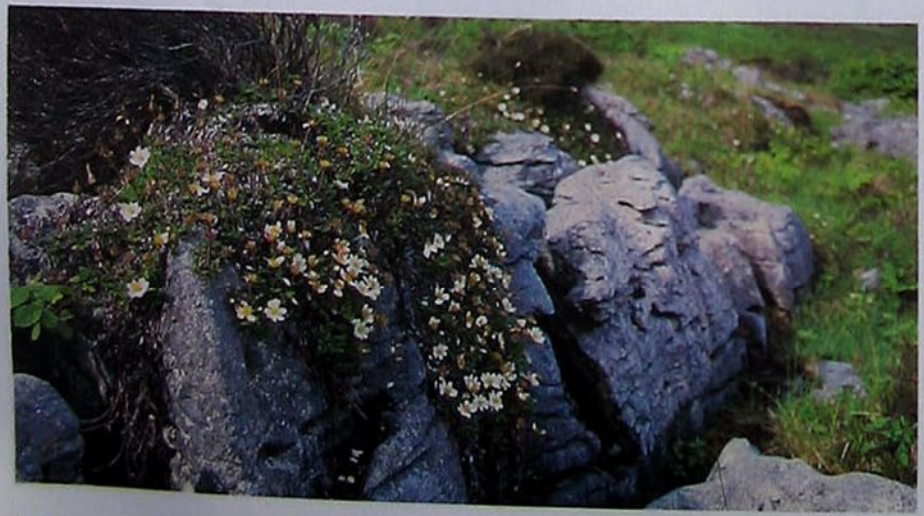
Drainage made the first cuts into the ancient plateau. The water-eroded valleys were later subjected to the abrasive ice sheets of the Pleistocene period, when glaciers moved down the valleys, broadening, deepening and polishing them, and also coating their sides with boulder clay.

Thus, about 10,000 years ago – a mere wink in the story of the rocks – the dales appeared in the form we recognise today.

Man – and his sheep The glacial lakes occupying the floor of many of the dales did not last. The once-generous cover of trees was cleared as man made more grazing space for his domesticated animals.

The wide-open appearance of the dales landscape today is largely a result of grazing by domesticated animals, chiefly sheep. This was a pastoral landscape 1000 years ago. When native woodland was cleared for pasture, the sheep ensured, by their constant browsing, that little natural regeneration of timber would occur. If you see an isolated tree on a hillside, it is more than likely that it is growing from a pothole, or from the side of a cliff where it has rooted beyond the reach

Above: A windswept hawthorn growing on limestone. The limestone terrain in the Yorkshire Dales is typified by cliffs and screes, dry valleys, pavements and potholes. Limestone soils are thin but sweet (rich in calcium). A rare flower, Jacob's ladder, grows at Malham Cove, and at nearby Gordale Scar the high terraces at the approach to the gorge are decked with yew. Ferns, which root in the moist and sheltered grikes (fissures) also flourish on limestone. In the wild, high places of the dales a few arctic-alpine flowers survive. Purple saxifrage (right), which blooms early in the year, is one, and mountain avens (below) is another. You'll only find mountain avens where sheep cannot graze.



of the ubiquitous sheep.

In quite recent times, over-stocking with sheep has debased many a fell, leading to the disappearance of heather from the drier ridges and to the formation of vistas dominated by mat grass.

The dales The best land is found in the dales, or valleys, themselves. Most of the old meadows and permanent pastures have been ploughed up and re-seeded with grass mixtures that include rye, and the result is a uniform green where years ago there were flower fields with a generous mixture of grasses, flowers and herbs. So few are the remaining old-style meadows that the Yorkshire Naturalists' Trust has acquired one as a nature reserve. A few upland meadows are still capable of producing such a huge crop of buttercups that there seems to be a yellow stain on the landscape.

At the road verges something of the old plant life endures. Many ancient thorn trees can be seen, and there is a seasonal profusion of such common plants as cow parsley and meadow cranesbill with, here and there, colonies or orchids.

The coming of the machines, which disrupted the nesting routine of a once-common bird, the corncrake, also means that waders (especially the curlew) are under assault from mowing machines when their young are but half-grown.

Most of the dales rivers today flow clear and cool, though they are frequently stained brown by peat. The gripping (mechanical drainage) of thousands of acres of hilly land means that rain runs off much more quickly than it once did. Also, an overspill of liquid from a silage pit can pollute the local beck and affect the main rivers.

Deciduous woodland A surprisingly large area of old deciduous woodland remains, most of it on steep fellsides, where it receives some protection from the weather and where the land is not of sufficiently good quality to be reclaimed for intensive farming. The fellside woods, which are generally on dry soils, grow an indigenous mixture of birch, hazel and ash. Lower down the dales, near Bolton Abbey in Wharfedale for instance, magnificent woods, mainly oak, spring from the moist boulder clays.

If the sheep have ready access, there is little ground cover for other animals. But in high untended woodland trees rot where they fall and are colonized by insects. The insects attract nesting woodpeckers (both the great spotted and the green), and open glades encourage woodcock to nest. Badgers also live in these quiet old woods.

The absence of sheep leads to a lusty growth of native plants. Ling Gill, in North Ribblesdale, has a bountiful flora because many parts of it are inaccessible to sheep, and just across the valley is a fenced-off wood, Colt Park, which is a good example of an ashwood growing in a deeply dissected limestone pavement.

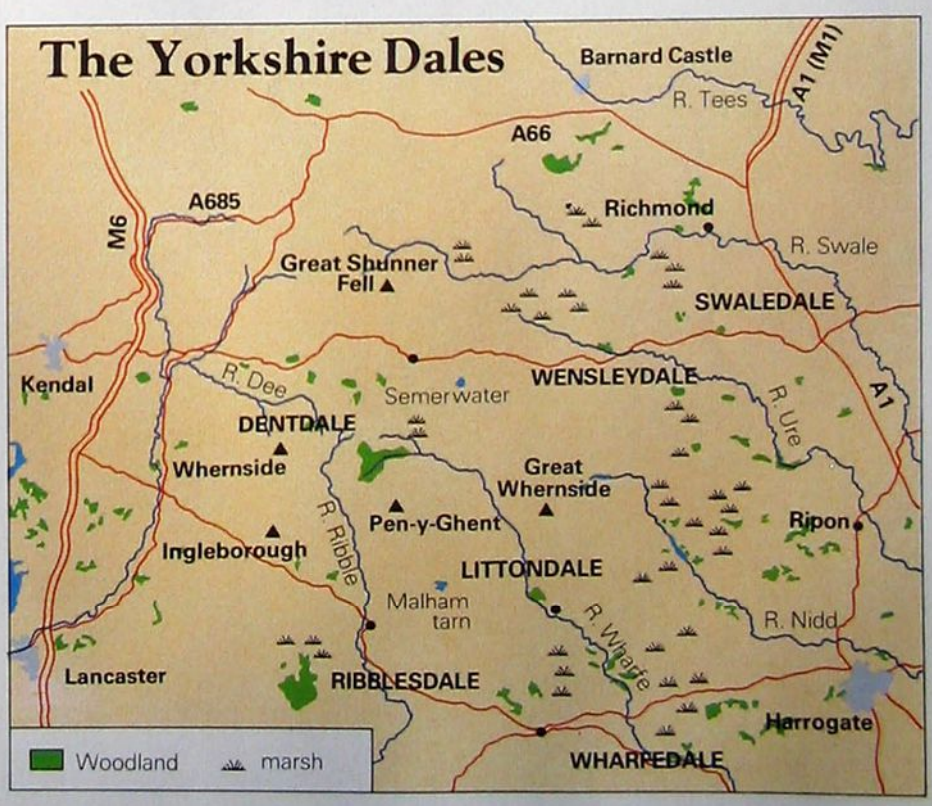
Crags and gills Steep-sided narrow gills (water-carved valleys) extend up to over 305m (1000ft) above sea level and, with their cliffs, are a favourite nesting haunt of the ring ouzel. The willow warbler is abundant, too, up to and above the heather line where there are no trees. The gills provide sheltered conditions for plants and wild creatures and greatly extend the moderating influence of the dales.

Industrial areas Some of the finest natural history habitats are in areas once devoted to industries that are now no longer in existence. The once-notable lead-mining industry poisoned the ground badly, but now patches of spring sandwort bloom on the arid land in spring. A former limestone quarry or a disused railway line, if neglected, soon burgeons into an outstanding area for plant life, and may have the added attraction of a pond or even a lake.

Old buildings themselves are quickly colonized by plants; elsewhere trees speedily

Above: The peregrine falcon (seen here with a chick) is an uncommon bird of the Yorkshire uplands, and the raven, too, is nearly as rare. The commonest bird is probably the humble meadow pipit, while the carrion crow appears everywhere. Dipper and grey wagtail can be seen on rivers and streams and the yellow wagtail haunts the moist lowland meadows. Wheatear and ring ouzel appear on the hills, along with nesting pairs of golden plover and dunlin. Lapwings are fairly common on marginal land, and everywhere—or so it seems—there are curlews nesting on hillside pastures or in lowland meadows.

Below: This map shows the location of some of the best-known Yorkshire dales.



establish themselves and, on banks of old debris where there is as yet little competition, a variety of orchids can be seen. One old quarry is noted for its bee orchids; another offers common, coral-root and frog orchids. There are also springtime drifts of bird's-eye primrose and clumps of globe flowers.

Heather moorland and mosses Over-grazing by sheep, and the colonization of areas of moorland by unpalatable grasses, have pushed back the heather line. In the North York Moors, too, vast areas of what was formerly heather moor have been reclaimed for farming.

A certain number of sheep pastured on the moors perform a useful task in keeping the heather to a reasonable height and encouraging new growth by their constant pruning; the problems begin when their numbers are excessive. Moorland fires, many of them started unintentionally by visitors, sterilise the peat, and afforestation with conifers not only changes the nature of the environment – it also provides an excellent refuge for such animals as foxes.

The high moors in the Dales country have fine populations of grouse. Here two male black grouse (above) confront each other. Gamekeepers burn old heather (below) to stimulate new shoots.

In spite of these destructive forces, however, the remaining moors are among the finest in Britain, and the red grouse stays faithful to its open, windswept heather landscape. With a specialised diet that is almost entirely composed of heather, there is no option for the grouse but to cling to the 'tops'. On well-managed moors old heather is burned, or 'swiddened', to stimulate new growth of shoots for the grouse to eat.

Sheep, grouse and 'swiddening' preserve the moorland in its open, treeless state. The moorland zone is generally between 305m and 381m (1000-1250ft) high and lies between the high pastures of the farmlands and the even higher cottongrass mosses.

The high moss country is characterised by considerable deposits of peat.

Such rough grazings extend to the summits of the highest fells where few creatures live. Dotterel have been seen on Ingleborough in May, a pair of ravens may nest where there are crags and occasionally the soulful whistle of a golden plover can be heard in the solitude.

Left: Two notable examples of standing water in the dales are Malham Tarn (shown here) and Semerwater. Malham Tarn stands in a bed of impervious Silurian slate. The water covers 62 hectares (153 acres) and is 365m (1200ft) above sea level. With its limestone cliffs, extremely high-lying woodland and expanse of water fed by lime-rich streams Malham Tarn Estate is the nesting place of the great crested grebe (among many other birds). Semerwater, from which the River Bain – claimed to be the shortest river in England – flows through Bainbridge to the River Ure, is much more sheltered than Malham Tarn. Among the birds in winter are Icelandic whooper swans.

THE UBIQUITOUS BANK VOLE

This small, mouse-like rodent leads a short but active life in woodlands throughout the British Isles; quite recently it has also appeared in south west Ireland. Like the closely related field vole it is an important food source for many predators.

Above: Bank voles have chestnut red upperparts, grey flanks and silvery grey to creamy buff underparts. They vary considerably in weight and size. Animals born late in the summer overwinter measuring about 9cm (3½in) in length. At the start of the breeding season in spring this increases to 11cm (4¾in). Weight also varies from 16g (½oz) in winter to 30g (1oz) in summer.

The bank vole, also known as the red backed vole, is small and mouse-like. In fact in some country districts it is called, rather misleadingly, the bank mouse or red mouse. However, several distinctive vole features distinguish it from a mouse. It has a shaggy coat of bright chestnut-coloured fur, quite unlike the sleeker, finer coat of a mouse. It has a blunt nose, small eyes, small ears which are almost hidden in fur, short legs and a short tail.

The bank vole is distinguished from its close relatives the field vole and the much larger water vole by its smaller size and the rich red of its upperparts. Its tail is long for a vole, being about half the length of its head and body, and its ears are slightly more prominent than those of other voles.

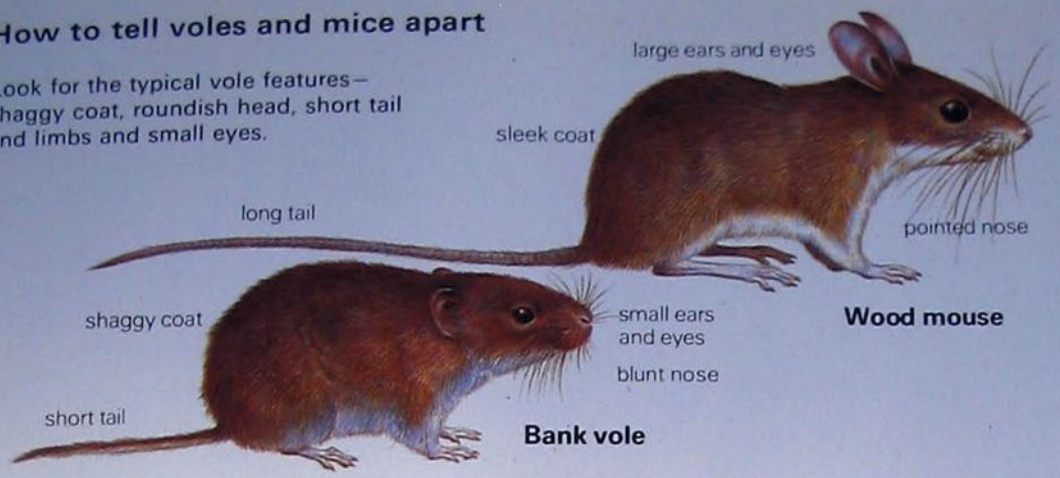
Woodland whereabouts The bank vole is found in deciduous woodland and scrubland, and along banks in hedgerows. Each bank vole occupies a home range of at least 45m (50yd) in diameter. It usually makes its home where there is thick cover, especially brambles and bracken, but it occasionally ventures on to open ground if the vegetation is sufficiently tall to give it cover, or if a bank or wall is present. It also lives along river banks and is an excellent swimmer. It could possibly be confused with a young water vole–however, a small, immature water vole would almost certainly be accompanied by a parent.

A busy forager The bank vole is a lively creature, busy by day and by night, but with an increase in nocturnal activity in the summer months. These short bursts of foraging are interspersed with periods of rest or sleep. It is an agile climber, but spends most of its time rushing about on the ground.

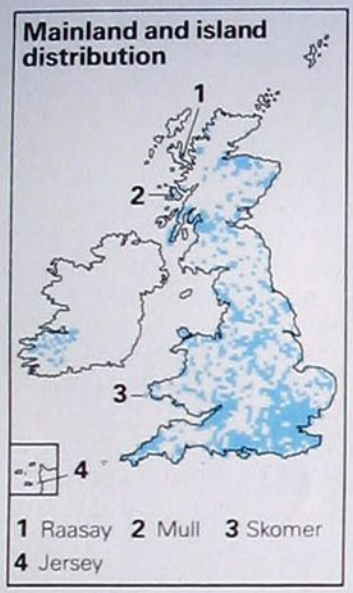
It is mainly vegetarian in diet, feeding on a great variety of plant material, such as leaves, fruits, seeds, nuts, berries, roots, fungi and the grain of wheat and barley. It also eats a small quantity of snails, worms, insects and larvae. In winter when green food is scarce the bank vole sometimes gnaws the bark of trees. The thick outer corky layer is of no interest and is often scattered on the ground below the gnawed branch. The inner living

How to tell voles and mice apart

Look for the typical vole features—shaggy coat, roundish head, short tail and limbs and small eyes.



BANK VOLE (*Clethrionomys glareolus*).
Size Max length (excluding tail) 11cm (4½in). Max weight 30g (1oz).
Colour Reddish above, grey on flanks, pale beneath.
Breeding season Usually April-October but may last through winter.
Gestation Usually 17-18 days, but up to 30 days.
No of young Average 4.
Lifespan 2-18 months.
Food Mainly vegetarian, but also eats insects and worms.
Predators Most predators.



Above: *Clethrionomys glareolus* is separated into five sub-species. The mainland sub-species is *C.g. glareolus, C.g. caesarius* is found on Jersey, *C.g. skomerensis* on Skomer, *C.g. alstoni* on Mull and *C.g. erica* on Raasay.

Opposite: A predator's eye view of a bank vole.

Below: Young bank voles in the nest.

part of bark attracts the vole, but because it is a small, weak animal its teeth do not penetrate very deep. It prefers trees with soft bark and climbs agilely up a tree to sit in the angle of a branch where it can gnaw in comfort.

The bank vole chatters and squeaks as it goes about its business, but its sense of smell, rather than these vocalisations, is probably a more important form of communication. Drops of urine are released at regular intervals, probably to mark the extent of its home range. The odour of faeces, and body smells, can convey an enormous amount of information and bank voles can even distinguish between their own odour and that of other sub-species.

The bank vole's home range is criss-crossed by a network of overground runways, and also underground tunnels, that centre on a nest constructed at a depth of 2-10cm (1-4in). Surplus food is sometimes stored in these underground tunnels.

A brief but busy life The breeding season is a long one, starting in April and continuing until late into October. If food, such as acorns, is in plentiful supply, breeding may continue through winter. On average there are four young to a litter and the female may produce up to five litters in a season. The female is ready to mate again immediately after the birth of her young.

The young are born blind and naked and spend the first days of their lives, when they are completely helpless, in the breeding nest. This may be below ground but usually it is above ground level, wedged in a crevice in a tree trunk or in an old tree stump. The female uses locally available materials to construct the nest, so in a woodland habitat leaves, moss and feathers are used, while in grassland grasses and moss are utilised.

At birth the young weigh only 2g. The grey-brown juvenile coat appears after four to ten days, and the first moult to longer denser fur occurs between four and six weeks later. Their eyes open at around twelve days old, they are weaned at two and a half weeks, and are sexually mature after four to five weeks.

Animals born early in the breeding season

Above: All four island sub-species of bank voles are larger than the mainland one. This Skomer vole is at least 30% heavier than the mainland vole. Its upperparts are a brighter red and its underparts are cream.

Left: The droppings are cylindrical, usually with rounded ends. The colour varies with diet: in summer they are usually greenish but in winter they are brown to black.

mature quickly and breed in the same year. These are likely to be sufficiently large and strong to survive the rigours of winter and will breed again the next season. However, those animals born late in the season grow slowly and do not reproduce until after their first winter, if they manage to survive at all. It is unlikely that any bank vole survives more than one winter, so two breeding seasons is probably the maximum. The lifespan varies considerably, from two or three months up to eighteen months, although they can live for 40 months in captivity.

Population fluctuations The bank vole population varies considerably throughout the year, usually reaching a peak in June and falling off towards the end of the breeding season when fewer females are reproducing and the average litter size is smaller.

The bank vole population may also vary considerably from year to year. The most common pattern is for the size of the population to increase gradually over several successive years and then quite suddenly, for no obvious reason, there is a dramatic drop in numbers. These cycles last on average three to four years, although British woodlands are not subjected to the enormous fluctuations that occur on the Continent. The reasons for these cyclical population changes have not yet been satisfactorily explained, although the sudden decline at the end of the cycle may be due to overcrowding.

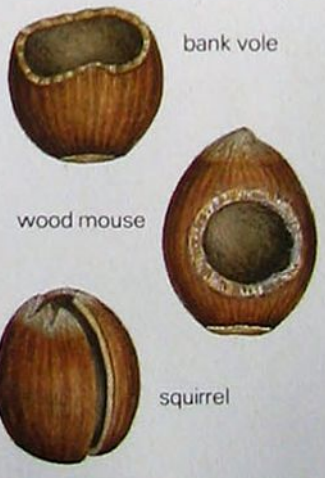
The bank vole's predators The bank vole forms part of the diet of most birds of prey and carnivores, especially those animals, such as the barn owl, tawny owl, kestrel and weasel, that hunt in woodland. A build up in the bank vole population is often accompanied by an increase in the numbers of those animals that prey upon it. These predators stay and breed in the area for a couple of years and then move on to new hunting grounds once the voles have declined in number.

Occasionally, when the food that forms its usual diet is in short supply, or when there is pressure upon that food supply due to an increase in numbers, the bank vole may become a forestry pest. Under these conditions it relies increasingly on tree bark as a source of nourishment, and can cause considerable damage, especially when it attacks young trees.

Distribution The bank vole is found throughout mainland Britain. As recently as 1964 a population was also found living in a limited area in the south west of Ireland. The Irish population is probably a recent introduction, although no one is sure how it arose. In addition to the mainland population the bank vole also inhabits certain widely distributed offshore islands. Four sub-species have been recognised on islands off Britain. They are Raasay, Mull, Skomer and Jersey–named after the islands on which they were found.

How rodents open hazel nuts

Like other rodents, the bank vole has its own special method of opening the thick, hard shell of the hazel nut to get at the kernel inside. It holds the nut underneath its body, using its forefeet to brace the nut against the ground. The base is wedged under its chest and the tip slopes away from the animal. Once the vole has made the initial hole in the shell it puts its snout inside and gnaws the side nearest to it, from the inside. This leaves a very clearly marked gnawed inside edge which contrasts with the undamaged outer edge. The wood mouse handles hazel nuts in much the same way as the bank vole, but it holds the nut with the base pointed outwards and the nut inclined towards its body. It makes a hole in the tip, occasionally in the side, and then inserts its lower incisors. It turns the nut as it gnaws, the upper incisors leaving a series of marks on the outside of the shell around the hole. The squirrel holds the nut in its forefeet, gnaws a hole in the top and inserts its lower incisors, using them like a crowbar to split the nut.



Above: **Hedge mustard** (*Sisymbrium officinale*).

Left: **Garlic mustard** (*Alliaria petiolata*).

FIELD-SIDE AND HEDGEROW FLOWERS

Among the wide variety of wild flower species found in our field-sides and hedgerows are some that were once common in the fields as well. Some have become established at the field edge to escape the more rigorous modern farming methods, while others climb in profusion over summer hedgerows.

The wild flowers growing at the edges of our fields today are fewer in number and variety than those found there 100 years ago. Many cornfield weeds, for instance, have disappeared from farm fields altogether as a result of modern farming methods. However, some species – finding the more protected and shadier conditions favourable – have remained, forming thriving colonies in the uncut grass and hedges at the field edge.

Hardy hedge-growers One such species, with many old local names aptly describing its location, is garlic mustard, also known as Jack-by-the-hedge and Jack-in-the-bush. In Elizabethan times the crushed leaves, which smell and taste of garlic, were used in a sauce eaten with boiled mutton or with salt fish; they are still used in spring salads today.

A shade-loving plant, it often grows in clumps in woodlands and against the dry stone walls of northern fields, as well as in sheltered hedgerows and shady corners of gardens and farmyards. The thin, pale green, triangular leaves are deeply and irregularly toothed and spread out below heads of small, white cross-shaped flowers which appear from April to June.

The hedge mustard, a related species, can live through the winter, growing rapidly in the first mild days of spring to flower early in the season. It is a stiff, wiry plant with twiggy branches growing at right-angles from the stem. The flowers appear from May to September and the stem elongates as the flowers open, so that the small, new, pale yellow flowers – shaped like a Maltese cross – are always at the top of the stem. The upright seed pods press tightly against the stem, giving the plant an easily recognisable shape. When ripe, the pods split from the bottom upwards, exhibiting a row of orange-brown seeds along their length.

Invasive climber If a weed can be defined as a wild flower that is growing in the wrong place, then bindweed is one which can drive gardeners and farmers to despair when it invades gardens and farm fields.

Once a weed of the cornfields, its attractive pink, or pink and white candy-striped, flowers now appear by the wayside, on derelict land and sometimes by the sea. It spreads rapidly by means of thick rhizomes that grow through the soil, rooting as deep as 2m (6½ft) below the surface. The slender,

Left: The hedge bindweed (*Calystegia sepium*) grows in hedgerows and wood edges in the Midlands and southern England. It climbs by twining around the stems of other plants, always in an anti-clockwise direction. The trumpet-shaped flowers, reaching up to 7cm (2¾in), are the plant's most striking feature. In bloom from July to September, they first appear as long white buds with two broad red or green-streaked bracts at the base. These unfurl and remain wide open even at night, attracting the long-tongued convolvus hawk moth, which arrives at dusk to feed from the nectar glistening at the base of the flower.

spiralling overground stems, up to 75cm (30in) long, twist around other plants–often so tightly that they are choked and die.

A similar species is the hairy bindweed, which has large, marshmallow pink flowers. This species was first brought from America to Britain as a garden plant. It escaped and has become naturalised, now growing in more than 100 localities throughout Britain.

Above: The attractive flowers of the bindweed (*Convolvulus arvensis*) set few seeds, as the plant spreads successfully by its creeping rhizomes. Even if the plant is dug up, the tiniest remaining fragment can grow into a new plant.

Mid-summer flowers The ox-eye daisy is a familiar flower of mid-summer fields and roadsides. The single, conspicuous flower head, reaching up to 5cm (2in) across, is composed of many tiny, individual flowers or florets. Small, yellow tubular florets make up the central yellow disc, surrounded by white, radiating, strap-shaped ray florets. One descriptive local name for this species is 'beams of brightness'.

Mugwort, (*Artemisia vulgaris*) like the ox-eye daisy, is another mid-summer flower. It has a rather dusty appearance and is often found growing by dry and dusty roadsides in late summer. The rather stiff branched stems reach heights of 120cm (4ft), but the wind-pollinated flowers are very small, brown and rather inconspicuous. The leaves are dark green above and lighter with grey-white hairs on the underside.

Mugwort was believed to have magical properties. St John's Eve in June was celebrated with bonfires, and mugwort plants were held in the smoke. They were then woven into garlands and hung over doorways to keep away evil spirits. The crushed leaves have a slightly aromatic scent and they have been used as an infusion to make herbal teas.

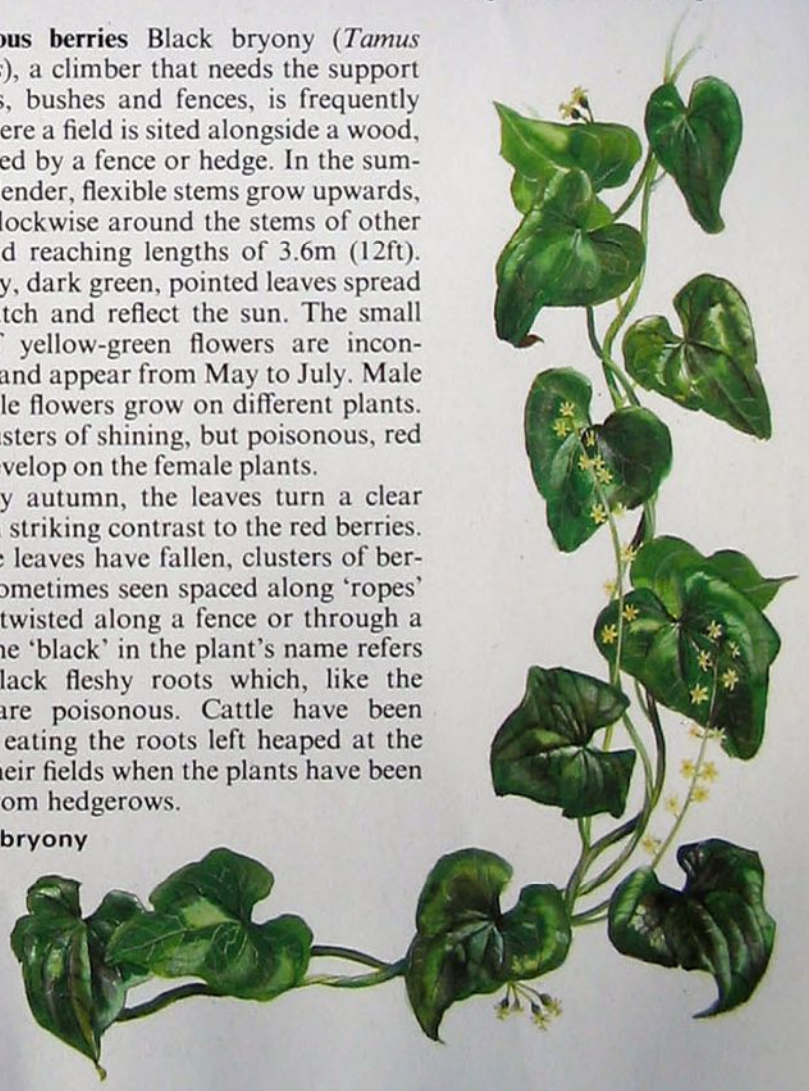
Mountain and hedgerow plant Despite its name, the mountain crane's-bill (*Geranium pyrenaicum*) is another species found in hedgerows and field-sides. In parts of Europe it is a true mountain species, growing in the Pyrenees and in the mountains of Portugal, Sicily and Greece, but in the British Isles it is found in lowland habitats and is sometimes known more appropriately as the hedgerow crane's-bill.

The deeply notched, purplish-pink petals form pairs of flowers in loose heads. The plant's miniature crane's-bill fruit grows upright, and when the seeds are ripe the style springs up like a coiled spring, flicking the seed up to 3m (10ft) from the parent plant. It is an effective method of dispersal, and this is one of our wild flower species that has increased its range considerably in the last 50 years.

Above: Ox-eye daisies (*Leucanthemum vulgare*) were once common in hay meadows. It is now more usual to find just a few plants in bloom from June to August at the field edge.

Poisonous berries Black bryony (*Tamus communis*), a climber that needs the support of hedges, bushes and fences, is frequently found where a field is sited alongside a wood, or bounded by a fence or hedge. In the summer the slender, flexible stems grow upwards, turning clockwise around the stems of other plants and reaching lengths of 3.6m (12ft). The glossy, dark green, pointed leaves spread out to catch and reflect the sun. The small spikes of yellow-green flowers are inconspicuous and appear from May to July. Male and female flowers grow on different plants. Later, clusters of shining, but poisonous, red berries develop on the female plants.

In early autumn, the leaves turn a clear yellow, in striking contrast to the red berries. When the leaves have fallen, clusters of berries are sometimes seen spaced along 'ropes' of stems twisted along a fence or through a hedge. The 'black' in the plant's name refers to the black fleshy roots which, like the berries, are poisonous. Cattle have been killed by eating the roots left heaped at the edge of their fields when the plants have been cleared from hedgerows.



Black bryony

THE OSPREY–A HIGHLAND RARITY

The osprey has suffered from a history of ruthless persecution by egg collectors and gamekeepers, causing it to be absent from Britain for over 40 years. Since the return of the first breeding pair in 1959, numbers have been gradually increasing.

Throughout the long history of their evolution, many different birds of prey have emerged, taking advantage of an immense variety of potential foods, and belying the popular impression that they all live on a diet of small mammals, birds or carrion. From the bat falcons of Central America and the insect-hunting falconets of eastern Asia to the monkey-hunting and even deer-hunting eagles, the range of predatory birds is truly wide, and few potential victims escape the attention of one or another of them. It is hardly surprising, therefore, that among birds of prey some highly expert fishers have evolved. The osprey is supreme among these: it is a large predator that hunts and breeds successfully in many parts of the globe, perfectly equipped to find all its food in water.

Plunging for prey The bird has a striking appearance: the white undersides of its body and wings contrast sharply with its rich brown upper plumage; and its length of 60cm (2ft) is dwarfed by enormous angular wings which, when fully spread, measure 145cm (5ft). It is capable of catching and carrying away fishes of several pounds in weight, but it rarely seizes the larger ones: most frequently it takes fishes between ½lb and 1lb (230-450g).

The osprey's plunge-dive is an awe-inspiring sight. It searches slowly over the water for suitable prey and when it has found a likely victim it banks, circles and hovers. Basking or surface-swimming fishes of many species, such as pike, perch, trout or carp, are all taken by the osprey. Quickly it enters a graceful plunge, at the end of which it takes its selected victim in its talons. Often the dive is fairly gradual, but sometimes it is almost vertical; and often the osprey plunges from heights of 16m (50ft) or more.

As the bird strikes the water, it thrusts its talons forward to take the fish (at the same time they help to absorb the impact of hitting the water). The osprey holds its wings high as it enters the water. It is thought that the bird seldom dives deeper than 1m (3ft), and usually goes a far shorter distance below the surface. Almost immediately it rises from the water again for, provided that the dive has been performed well, the bird has little difficulty in regaining the air.

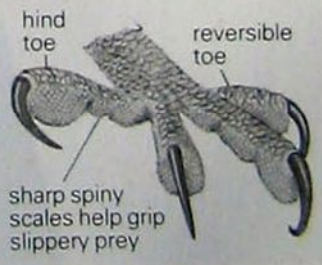
Terrible talons The feet of the osprey are specially adapted to assist it in seizing and retaining such slippery prey as fishes. The feet and legs are particularly large and powerful; the claws are strongly curved, and the undersides of the feet are equipped with spiny scales that grip the body of the fish. Perhaps most remarkable of all is that one of the four toes is completely reversible–the osprey can turn it either backwards or forwards. With this toe pointing back, alongside the true hind toe, the osprey can hold a fish securely by two claws in front and two behind. Once it has risen from the water, the osprey turns the fish so as to hold it in a fore-and-aft position and carries it away to eat it at leisure. Ospreys digest even the bones of fishes without difficulty.

Osprey (*Pandion haliaetus*). Rare summer visitor, 23 pairs recorded in 1981, numbers slowly increasing. Breeding in the Highlands of Scotland. Two or three eggs, richly marked in reddish brown or chocolate colour. Length 60cm (2ft), wingspan 1.4m (5ft).

Opposite: The large nest is made of sticks and a typical site is in the top branches of a Scots pine or other tree. Ospreys have been known to build nests on tall buildings or high cliffs. The two birds seen in this nest are juveniles.

From the edge of extinction In 1981, as many as 23 pairs of ospreys were known to be breeding in Britain, all of them in the Scottish Highlands. For over 40 years in the first half of this century, this splendid bird was extinct as a breeding species–a result of ruthless persecution, mainly by egg collectors. The eggs were considered a great prize by enthusiasts, whose determination to build up their collections led to the disappearance of the species from Britain.

Another major cause of the decline of the osprey in Britain over the past 200 years was the fact that it depends on fishes for its living. Gamekeepers and water bailiffs assumed that this made the osprey a serious competitor with man for the fishes in Britain's rivers and lakes. The latter part of the 19th century was a particularly ruthless period of game preservation and unbridled destruction of any



Above: A female feeding her young. At first only the male fishes, but later both parents are needed to find food for the growing family.

Below: Mating begins soon after the female has arrived in the nesting area.

wildlife that seemed to threaten stocks of game fishes such as trout and salmon.

Even today, following its return to the Highlands, the osprey has not been slow to learn the attractions of modern fish farms, and has sometimes caused losses to the owners of these enterprises. However, fish farmers normally have no difficulty in scaring off the ospreys, while many are prepared to tolerate the presence of these beautiful and rare birds, provided their visits are reasonably short.

After its period of extinction, the osprey quite unexpectedly made its appearance in Scotland in 1955, visiting but not breeding during four successive seasons. Then in 1959 a pair of ospreys raised a brood at a site in the RSPB reserve at Loch Garten in Speyside, in Scotland's Highland region. The RSPB set up a visitor centre at Loch Garten, so that while the ospreys regularly breed in the safety of the reserve, thousands of visitors each year have the chance to see these majestic birds without causing them undue disturbance. The centre has become one of the most exciting wildlife facilities provided for the public in Britain.

Summer in Scotland The Highlands of Scotland are the only part of Britain where ospreys breed. Here, a multitude of freshwater lochs and an unlimited choice of suitable nesting sites are available. Typically the osprey's nest is built on top of a Scots pine, but other species of tree and different sites are sometimes chosen. Some of the legendary Scottish sites in the last century were on ruined island castles. In coastal areas, the nest is sometimes on a cliff or an offshore pinnacle of rock.

In the Highlands, ospreys may travel several miles from one water to another to

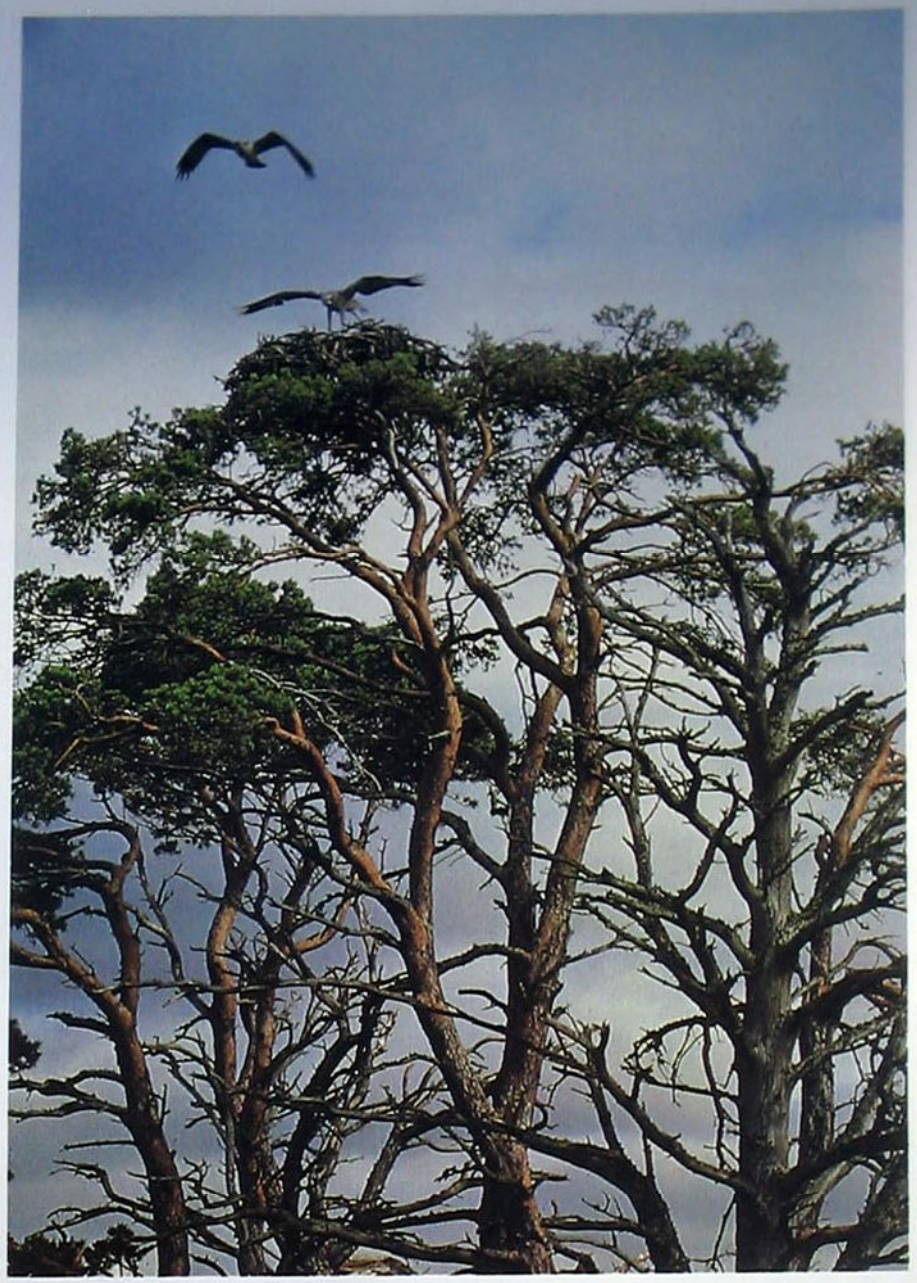
find better fishing if the need arises. Although the British population is essentially a freshwater one, ospreys in some other parts of the world are exclusively coastal birds, and feed at sea and in shallow estuary waters.

The Scottish birds return from wintering in early or mid April – the older, more experienced birds arriving first. Once a pair of ospreys has settled at the nesting site – the male sometimes arriving a few days ahead of the female – they start to breed. The male undertakes all the fishing, while the female remains close to the nest. A spectacular sight at this time is the male's thrilling aerial display of soaring, swooping and undulating flight, which he accompanies with shrill calls. Mating occurs frequently up to the start of incubation, and begins from the first days after the female's arrival. Two or three eggs, which are marked with rich brown or chocolate coloured flecks, are laid; they are incubated for five weeks, and the young hatch at intervals corresponding with the two or three day interludes between laying.

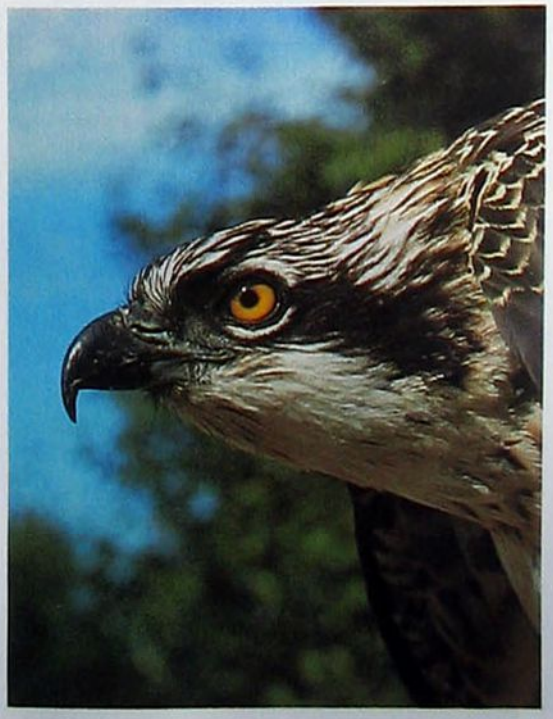
World-wide species The osprey is one of the most widely distributed birds in the world, breeding all across the temperate latitudes of the northern hemisphere. There are some coastal populations of ospreys in the Mediterranean and North African region and in many parts of the Far East as well as Australia. In North America, where there are both coastal and inland populations, a highly successful method of attracting ospreys to nest in a given neighbourhood has been developed. Osprey wheels – usually cartwheels – are set up on top of poles, and the birds soon begin to settle on them.

The northern breeding birds are strongly migratory and, as the fishes move deeper below the water surface with the arrival of autumn, the ospreys set off on the long flight to West Africa. Recoveries of ringed birds – several of these proving to be the victims of hunters – indicate their route through Iberia and north-west Africa to Mauritania and the Gambia. Ospreys en route for the south are frequently seen in many parts of England and Wales (presumably some of these are Scandinavian birds), and they are also seen flying north on the return journey in April and May. In between these times, the birds while away the winter months in the easy fishing of warm tropical waters.

Over 50% of ospreys, as in the case of most other birds of prey, die in their first year, due to various factors including the poor ability of the young birds to feed and defend themselves. Those lucky enough to be still alive remain in their tropical habitat until the third year, by which time they are in breeding condition. At this stage, they are also ready to undertake the long flight to the north. Pairing takes place while the birds are still in Africa. By the time the female reaches Scotland, the male will have found a good site and perhaps begun to build the nest.



Above: Supervised from overhead by the mother, a young osprey makes its first flight. The father is often away from the nest, either finding fishes or, if he has already brought enough for the day, sitting quietly on a favourite perch near the nesting tree.



Left: A young osprey, in the typically hunched attitude of the bird at rest. The sharply hooked beak is useful for tearing and eating fishes, the only food of ospreys.

FLIES OF WATER AND WOODLAND

You can sometimes see alderflies sitting on pond vegetation in early summer, but you have to search for the less familiar snakeflies.

Alderflies and snakeflies together make up a group of archaic insects known as the Megaloptera, meaning 'large wings'. They are usually treated as a subdivision of the lacewing order Neuroptera (or 'nerve-winged' insects).

Awkward alderflies Only three species of alderfly are found in Britain, the commonest being *Sialis lutaria*. This is a rather drab insect, measuring about 10mm ($\frac{3}{8}$in) long, with a wingspan of 22mm ($\frac{7}{8}$in), although the females are rather bigger than the males. They are heavy, awkward insects and do not fly well; in fact, they often prefer to run if disturbed, or fall to the ground. In May and June they are common near ponds and slow, muddy streams, resting on vegetation, fences, walls and tree trunks.

Mating and egg laying Mating takes place in the summer, when the male crawls below the female, curving his abdomen upwards and forwards in order to fertilise the eggs. The female lays her dark brown, cylindrical eggs near the water in regular rows of compact masses containing 200-500 eggs. These hatch after 10 or 14 days and the tiny larvae make their way to, or fall into, the water. As the eggs are often laid some yards from the water's edge, there must be a high mortality rate as the young larvae seem to have no method of finding water other than simply crawling downhill.

From aquatic larvae to adult Alderfly larvae are among the commonest of aquatic insects. You can spot them easily, as they creep about on the muddy bottoms of ponds and slow streams, where they feed voraciously on other small animals such as midge larvae and mayfly nymphs. They seize their prey with their strong, sharp curved mandibles and often attack other larvae as large as themselves. They have normal chewing mouthparts, quite unlike those of the lacewings, to whose order they belong. In fact, alderfly larvae are very similar to the larvae of some beetles, and if you caught one you could be excused for mistaking it for the larva of the whirligig beetle.

The whole alderfly life-cycle lasts about one year. The larvae spend autumn and winter at the bottom of ponds and are full grown by the spring. They then leave the water and make pupal cells in nearby debris or soil. Unlike the familiar all-in-one chrysalis of the butterfly, the legs and wings of the alderfly pupae are relatively free from the body and so after about three weeks they can actively make their way to the soil surface for the final change to adult form.

On sunny days the adults can be seen in large numbers on reeds and other vegetation by ponds and streams, but they never fly very far from water. They probably do not feed on anything solid, but may take some liquid.

Hide-away snakeflies At first sight, snake-

Above: The alderfly *Sialis lutaria* has two pairs of broad, smoky brown wings held in a sloping roof-like fashion over its blackish body. These wings are quite broad and have a strong, coarse vein system supporting the membrane. Although the wings look efficient, alderflies are not, in fact, very adept at flying.

Below: Each female alderfly lays about 500 eggs near water—on leaves, stones and overhanging foliage.

flies seem very different from alderflies. However, entomologists have made careful studies of their heads and wings and come to the conclusion that they are best put into the same suborder Megaloptera.

There are four British species of snakefly, two of which – *Raphidia notata* and *R. maculicollis* – are reasonably common in mixed oak and pine woodland. They are a little larger than alderflies, *R. notata* growing up to 15mm ($\frac{5}{8}$in) long, with a wingspan of 28mm (1in). The adults are blackish brown and hold their broad, clear wings in the same manner as alderflies. Unfortunately, snakeflies are quite difficult to find as they live in the foliage of trees and bushes, preying upon soft-bodied insects such as aphids.

They mate in a similar fashion to the alderflies, the male snakefly crawling below the female. She has a long, needle-like ovipositor with which she lays up to 300 eggs in batches of about 50 in bark crevices or beneath loose bark. The different species tend to choose the bark of different trees, the most common species preferring pine, although *R. notata* also chooses oak, especially if the bark is loose or there are dead branches. The eggs hatch into rather flat, predatory dark brown larvae in two to three weeks.

The larvae have large heads equipped with strong mandibles and spindle-shaped abdomens, giving them a waisted look. Their strong legs and tough skin enable them to move backwards and forwards in the bark crevices. When full grown, after going through about nine or ten moults, they measure about 15mm ($\frac{5}{8}$in) long.

Looking for larvae The easiest place to find the larvae is beneath the loose scales of pine bark in mixed woodland, but you should search for them in late summer when they are nearly full grown. They feed on any small, soft-bodied creatures such as aphids, scale insect eggs or young nymphs, springtails, mites or beetle larvae. Although the female snakeflies are said to choose egg-laying sites where beetle larvae are tunnelling, this seems unlikely as the beetle tunnels are not usually open and each would house only one larva.

Ferocious pupae and adults The two common species of snakefly pupate at different times. *R. maculicollis* pupates in the autumn and passes the winter in hibernation. *R. notata* overwinters as a larva and in the early spring looks for a place to pupate among the debris at the foot of the tree; it does not spin silk but makes a loose cell. The limbs and appendages of the pupa, like those of the alderfly pupa, are free from its body and it looks exactly like an adult with short wings. It has well developed mandibles and will try to bite fiercely if disturbed.

The pupa stays in its cell for three weeks before emerging to crawl actively about seeking a suitable place for its final moult. When the adult emerges in early May, it is often rather conspicuous because its wings are whitish at first. You should look out for the adults at the foot of pine trees at this time of year.

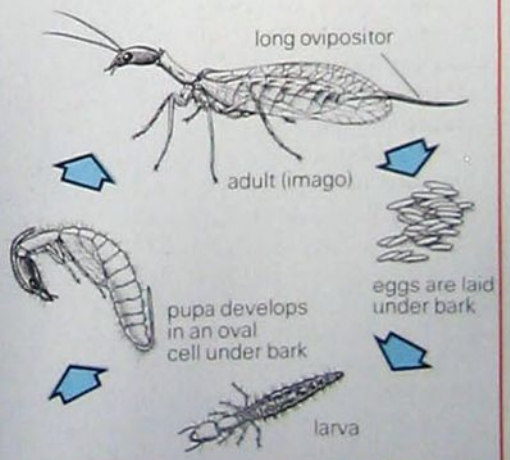
The adults of both species fly quickly into rank foliage, bushes or higher up in trees, looking for prey, and are thus much more difficult to find than the larvae. They live for quite a long time and can be found until July.

Above: A snakefly larva is full grown after about nine moults, when it measures 20mm ($\frac{3}{4}$in). It has a tapered abdomen ending in a slender, hair-fringed tail and walks on the pond or stream bottom with its six strong legs. There are seven pairs of five-jointed gills along the sides of the abdomen, one pair to each of the first seven abdominal segments. Each of the gills – which are also hair-fringed – contains a trachea (air tube) as well as blood, and they extract oxygen from the water so that the larva has no need to come to the surface to replenish its air supply.

Below: Snakeflies have a rather unusual body shape. The front part of the thorax (the prothorax) is long and held erect at an angle to the rest of the body. The head is bent forwards so the impression given is that of a snake poised to strike. The ovipositor of this female snakefly (*Raphidia maculicollis*) is as long as her abdomen and projects out behind.

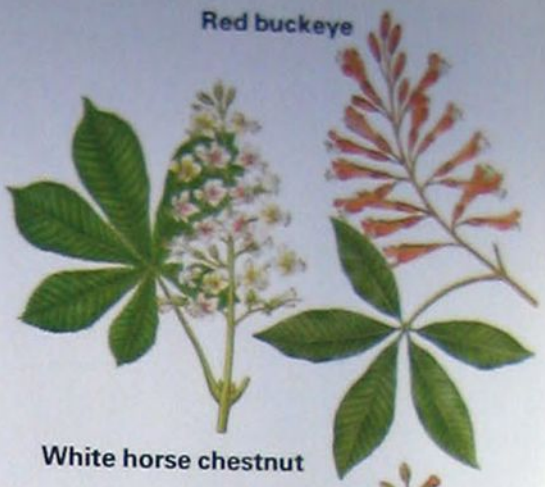
Life-cycle of the snakefly

The eggs laid in the summer by the female snakefly hatch into larvae after two or three weeks. These pupate in autumn or spring, depending on the species. The pupae resemble small-winged adults, and the adults emerge in early May.



TWO UNUSUAL HORSE CHESTNUTS

Next time you see a horse chestnut tree, take a closer look, for it might not be the familiar white-flowered species. Britain's parks and gardens also boast a pink-flowered hybrid form and the much grander, though rarer Indian horse chestnut.



Parks, gardens and other public areas are all good places to see both the pink and the Indian horse chestnut since, like their more familiar relative, the white horse chestnut, they are planted for their ornamental value rather than for commercial purposes.

Telling these three species apart is easy when they are in flower, because the pink horse chestnut has distinctive pink or red flowers while the Indian horse chestnut blooms in June or July, which is at least a month after the other two. Outside the flowering season, identification is more difficult but, with practice, both the leaves and the buds can be used as reliable guides.

Pink horse chestnut This tree is more common than the Indian horse chestnut, though it is far less attractive. It is a hybrid between the white horse chestnut and the much less common red buckeye, a North American species that was introduced to Europe at the beginning of the 18th century. Both trees are members of the same genus, *Aesculus*. The first hybrids are believed to have arisen by chance in Germany around 1800, though they were not noticed until 20 years later.

As with all other hybrids, the pink horse chestnut has characteristics intermediate between those of its parents. For example, the white horse chestnut has sticky buds and the red buckeye has non-resinous buds, so the buds on the pink horse chestnut are only slightly sticky.

The pink horse chestnut is a smaller tree than the common white species, usually growing to 15m (50ft) high, though in favourable sites occasionally reaching a height of 20m (65ft). The bark is reddish-brown and slightly rough to the touch. At the base of older trees it may become fissured into small plates, but never to the same extent as on the white horse chestnut.

When the tree is old the trunk often develops strange eruptions in which the bark and the wood beneath become powdery and decay; no one yet knows the cause.

Leaves, flowers and fruits The leaves of a pink horse chestnut are borne in opposite pairs on the shoots, each leaf consisting of five or seven leaflets joined at one point on the end of the leaf-stalk. Such an arrangement is known as palmate-digitate since it resembles the fingers on a hand. The leaflets are generally smaller than those on the white horse chestnut and they are a darker or duller green, crinkled and coarsely toothed.

The flowers, however, bear a close resemblance to those of the red buckeye, since they are pink and have four petals (on the white horse chestnut the flowers are white with touches of pink and have five petals). All members of the genus *Aesculus* bear their flowers in clusters on erect panicles, and the pink horse chestnut is no exception. The flowers appear in May at the tips of the current year's shoots on panicles 12-20cm (5-8in) long.

Unlike the fruits of the white horse chestnut, which are extremely spiny, the fruits of the pink horse chestnut have short, blunt spines (if any), and you can handle them without fear of being pricked. They are also smaller (up to 4cm/1½in long) and pale brown instead of green. Inside, the seed of the pink horse chestnut lacks the glossy brown of the familiar 'conker'.

Fertile hybrids The pink horse chestnut has a curious history. Although both its parents belong to the game genus they are very different from each other (they are said to belong to different sections of the genus, and some botanists even place the red buckeye in a separate genus, *Pavia*). With such disparate

Above: The pink horse chestnut is a hybrid produced by crossing the white horse chestnut with the red buckeye. It has inherited characteristics from both of its parents.

Pink horse chestnut (*Aesculus* × *carnea*). Deciduous tree with pink flowers and crinkled leaves. Height to 20m (65ft).

Below and right: Panicles of pink horse chestnut flowers appear in May. Note the palmate-digitate arrangement of the leaves typical of *Aesculus*.

Above: The leaves of an Indian horse chestnut are more slender than those of the common white species.

Right: The flowers on the Indian species are larger and borne in longer panicles than on the white horse chestnut. They also appear later in the season, in June or July.

Indian horse chestnut (*Aesculus indica*). Introduced deciduous tree, native to the Himalayas. Height to 20m (65ft).

parents, the earliest hybrids were unable to produce viable seed – they were sterile, as the mule, which is a cross between the donkey and the horse, is sterile.

The sterility of the pink horse chestnut continued until 1896, when a tree at the Royal Botanic Gardens, Kew, produced viable seed, from which six or so plants were raised. These young plants turned out to be identical to their parents, apart from having slightly darker flowers. The pink horse chestnut overcame its infertility by a complicated process involving the doubling of its chromosomes. Some pink horse chestnuts are still sterile, but many now produce a full complement of seeds.

Indian horse chestnut This species is altogether more impressive than the pink horse chestnut. It belongs to yet another section of the genus *Aesculus*, since it differs in several important respects from other members, particularly in its leaves and fruits.

Their sticky but characteristically squat buds open in spring to reveal pink or wine-coloured young leaves, which soon turn dark green. Each leaf consists of five, seven or nine leaflets arranged in the same way as on the white horse chestnut, though each leaflet is stalked and noticeably more slender.

The flowers are borne in erect cylindrical panicles, up to 40cm (16in) long and consisting of as many as a hundred flowers. Each flower has two pairs of petals, the larger pair white with a red or yellow blotch at the base and the smaller pair white flushed with pink.

The Indian horse chestnut flowers in June or July, which is at least a month after the other horse chestnuts. The fruits correspondingly develop a month or more later, usually in late November or December. These are pear-shaped and rough-skinned, though not spiny. Each fruit is about 8cm (3in) long and green-brown. Inside is a rich chocolate-brown seed, which is highly glossy and large.

Despite its name, the Indian horse chestnut does not come from India; it is native to the north-west Himalayas from Kashmir to western Nepal. It was introduced to Britain in 1851 but, even today, it is not yet as popular as it deserves to be, considering its beauty.

Above: The leaves of an Indian horse chestnut are pink or wine-coloured when they first unfurl but quickly become dark green. The tree gives no autumn colour but stays green until late autumn.

Left: The Indian horse chestnut bears pear-shaped fruits that consist of a shiny chocolate-brown nut enclosed by a rough-skinned but spineless case. They fall from the trees in late November or December.

CUCUMBERS AROUND OUR COASTS

With a frill of tentacles around its mouth and rows of tube-feet running along its body, the sea-cucumber is one of the strangest creatures to inhabit our coastal waters.

Sea-cucumbers belong to a group of animals known collectively as echinoderms. Among the more familiar echinoderms are starfishes and sea-urchins. Echinoderms form a major branch of the animal kingdom but, apart from the few well-known animals, most of its members are seldom seen since they inhabit the sea-bed, often quite deep down.

The echinoderms are divided into five classes: the sea-cucumbers, the starfishes, the brittlestars, the featherstars and the sea-urchins. At first sight this seems an unlikely collection of animals. The starfishes, brittlestars and featherstars are, for the most part, many armed creatures, whereas sea-urchins are round and spiny and sea-cucumbers are mostly sausage-shaped. Yet, a closer study reveals that the various members of this group have a great deal in common.

One important characteristic of echinoderms, distinguishing them from other animals, is that their bodies exhibit a basic division into five equal parts. This division is obvious in the common starfish, whose five arms can be clearly seen, but on a sea-cucumber this arrangement is not at all clear. However, it is still there, for most sea-cucumbers have five rows of short suckers running along the length of their bodies.

Tube-feet for walking These suckers are known as tube-feet. They are another important characteristic of echinoderms, and no other creature has them. On a starfish, the tube-feet are situated on the undersides of the arms, a fact that helps to show the relationship between the bodies of starfishes and sea-cucumbers, despite the obvious differences in shape. Imagine the arms of a starfish being raised, so that its tube-feet are pointing outwards, and then joined together along the sides. If this shape is now stretched, you have a cucumber-shaped object with five rows of tube-feet. In other words, you have a sea-cucumber.

Above: The sea gherkin (*Cucumaria saxicola*) is confined to the coasts of south-west Britain and south-west Ireland. It lives along the intertidal zone of the shore beneath stones and in crevices.

Below: Britain's most common sea cucumber is *Holothuria forskali*, sometimes known as the cotton-spinner. It inhabits the western English Channel and the Atlantic, from the shore out to a depth of 70m (230ft).

The tube-feet are elastic and perform several functions. By expanding to create a partial vacuum they can grip the surface of the sea-bed. The sea-cucumber and some other echinoderms have suckers on the ends of their tube-feet to get a better grip. By alternately gripping and releasing, sea-cucumbers slowly crawl along the sea-bed in search of food.

A few sea-cucumbers burrow into the sand or mud with a worm-like action. These species do not have tube-feet on the sides of their bodies since they do not need to crawl.

Tube-feet for feeding Whether a particular species of sea-cucumber has tube-feet along its body or not, it certainly has them around its mouth for catching food. These tube-feet have become specially adapted for the task, being elongated into feathery-tipped tentacles.

In some species these tentacles are used to trap small particles of food drifting nearby,

which are then transferred to the mouth. The food particles consist of diatoms and the organic remains of dead organisms that continually rain down through the sea and settle on the sea-bed. This food source is called detritus. Other species use their tentacles to sweep up debris from the sea bottom, and a few species have evolved to exploit both ocean-borne food and bottom mud for whatever organic materials it may contain.

The structure of sea-cucumbers At the end of the sea-cucumber's body away from its mouth lies the anus, which leads into a cavity called the cloaca. This, in turn, is connected to the intestine and also to organs, called respiratory trees, by which the animal breathes. These consist of branching ducts into which fresh sea-water is pumped and then, when most of the oxygen has been used, is squirted out.

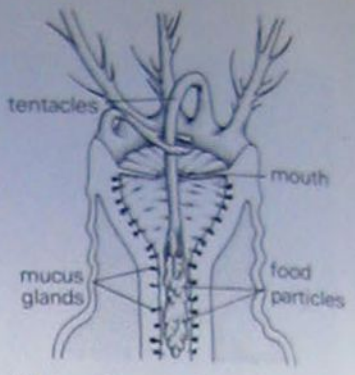
Certain species have special structures called Cuverian organs that open into the cloaca. These organs are used for defence– when the animal is threatened they discharge sticky white threads to entangle and deter potential predators. If the intruder is not repelled then, as a last resort, the entire gut may be discharged. Within a few weeks the gutless sea-cucumber regenerates a new intestine; in the meanwhile it survives on stored food reserves.

Life cycle In almost all species of sea-cucumber there are two distinct sexes. The female releases eggs and the male releases sperm, so that, in many species, fertilisation and the growth of the larva take place in the open sea. In others, the eggs and young are brooded. The moment when the eggs and sperm are released is carefully timed to ensure that neighbouring sea-cucumbers spawn together. This greatly increases the chance of fertilisation occurring.

In externally fertilised species, the larva lives in the upper levels of the sea, feeding on plant plankton. It changes its form several times as it matures and settles on the sea-bed.

British sea-cucumbers The most common species of sea-cucumber found on the shores of Britain is *Holothuria forskali*. It is also the largest British species, reaching a length of nearly 30cm (1ft). Its common name is the cotton-spinner since the white threads ejected by its Cuverian organs closely resemble cotton fibres. The upper surface of the cotton-spinner is dark brown or black and covered with reduced, wart-like tube-feet. Beneath, it is yellow-brown and has rows of well-defined tube feet for walking.

A common burrowing sea-cucumber is the worm-cucumber (*Leptosynapta inhaerens*). This species has a large number of calcareous spicules embedded in its soft body wall. Each spicule is shaped like an anchor, the points of which protrude through the skin and stick to your hand if you touch them. The creature uses these to give it purchase in mud.

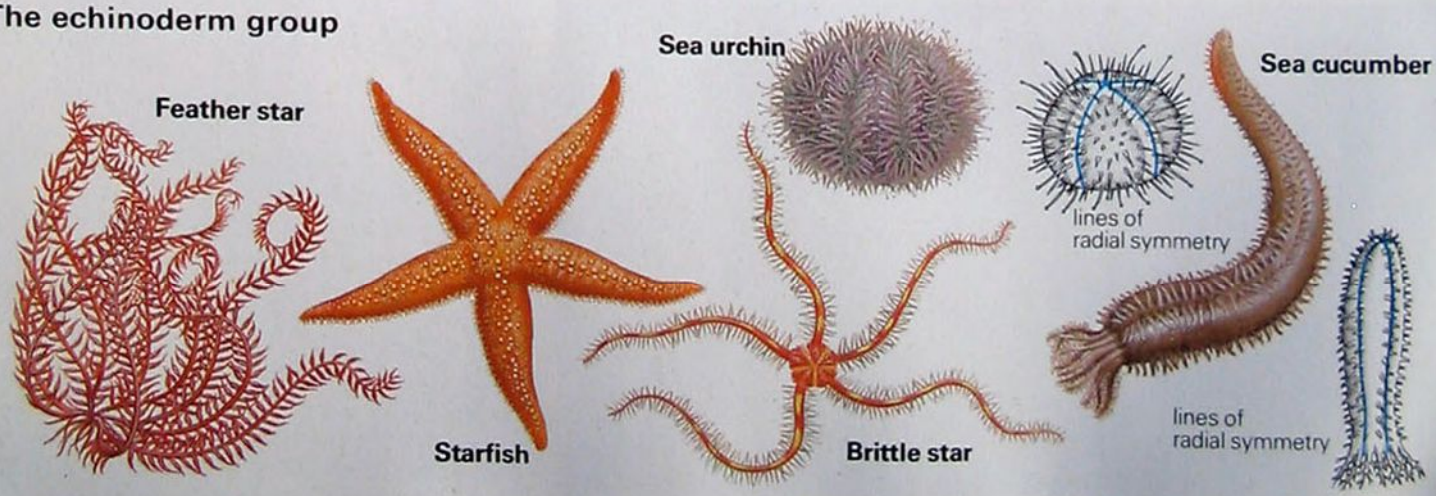


Above: *Cucumaria elongata* feeds on drifting detritus by trapping it with its tentacles. These are then inserted into its mouth, each in turn, and wiped clean.

Above: The head of *Cucumaria elongata* with its feeding tentacles. Rows of tube-feet can be seen along its body. This species is found on muddy sea-beds beyond a depth of 5m (15ft), around our coast.

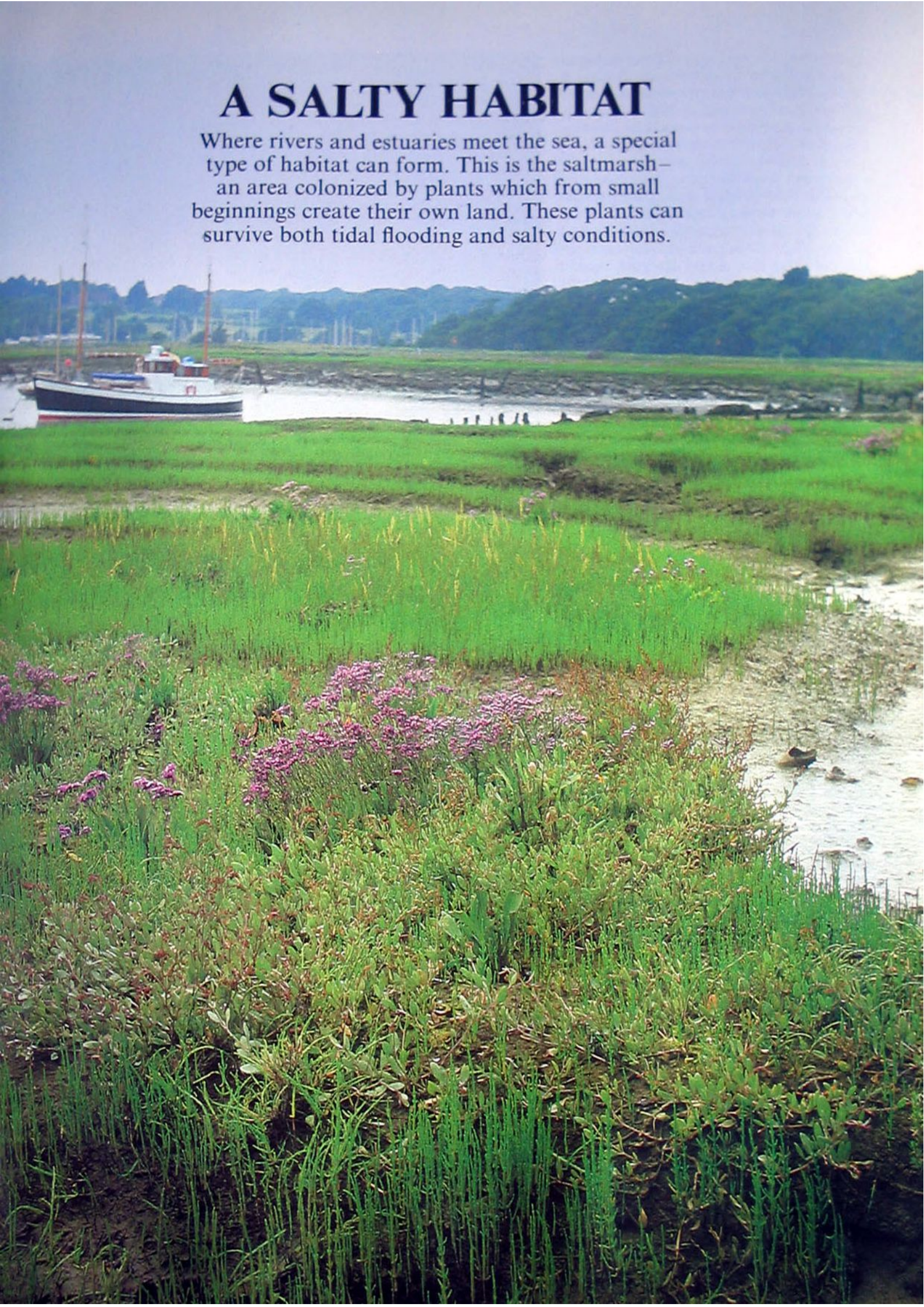
Right: The worm cucumber (*Leptosynapta inhaerens*) has no tube-feet apart from those around its mouth. It burrows into sand and mud at depths of 10-50m (30-150ft) in the Atlantic, the northern North Sea and the western English Channel.

The echinoderm group



A SALTY HABITAT

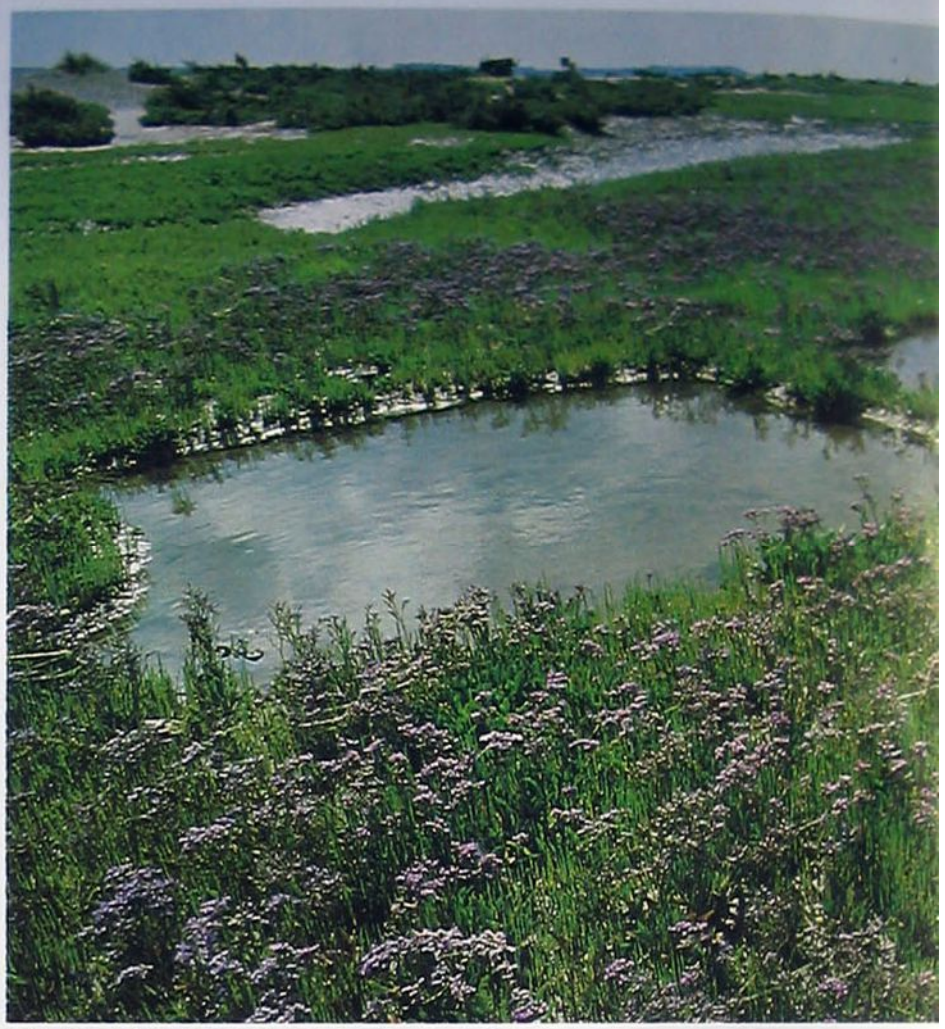
Where rivers and estuaries meet the sea, a special type of habitat can form. This is the saltmarsh– an area colonized by plants which from small beginnings create their own land. These plants can survive both tidal flooding and salty conditions.



The process of creating a saltmarsh begins when the flow of silt-laden water coming in on every tide is slowed down so that some of the load must be dropped. Mud flats slowly grow higher until just enough light, for long enough on every tide, can penetrate the murky water and allow plants to grow.

Eel grass, much eaten by geese in winter, and algae like the bright green *Enteromorpha* which forms striking carpets at low water, are the first plants to stabilise the bare mud surface. Their growth helps to trap more silt and the mud flat grows upwards until it shows its face to the air for two or three consecutive days at a time, even at fairly high water. Now the first true saltmarsh plants can gain a roothold.

The pioneers Glasswort is one of the first land settlers. Sprouting from the bare mud like a forest of miniature trees, these salt-tolerant little plants trap yet more silt–as much as 3cm (1in) a year, most of it in the autumn. The fleshy stems and branches, which are well-adapted to retain the plant's moisture, are smoothly curved to offer the least resistance to the currents that try to shift the seedlings from their shallow-rooted anchorages.



Left: One of the first plants to stabilise the bare mud surface is the bright green alga *Enteromorpha,* which helps to trap silt from sea water.

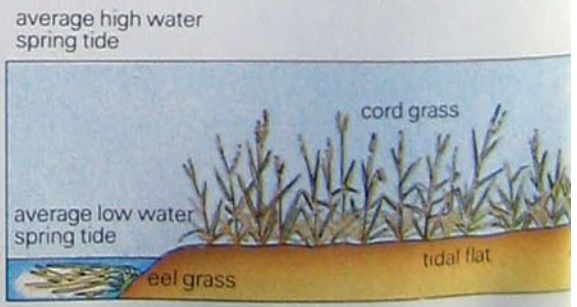
Previous page: A saltmarsh at low tide with empty creeks. Among the plants you can see here are cord grass, sea lavender, glasswort and sea purslane.

Below: Sea lavender forms a carpet of attractive pink flowers on the middle marsh in summer.

Cord grass, the other main pioneer on the lowest level of a saltmarsh, can establish itself where stronger currents prevail, since it has a strong root system that can resist the drag of the current. This relative newcomer is taking over the role of primary colonist in many places. A vigorous hybrid which can grow from root fragments as well as seed, it generally accumulates between 5 and 10cm (2-4in) of silt each year.

In the pioneer zones of the lower marsh these plants spend much of their time submerged, accompanied by such creatures of the mud as molluscs and worms. Fishes and shrimps swim among them when the tide is in, while birds feed when the mud is revealed at low water.

Middle and upper marsh As the silt-trappers



continue their work, the marsh is gradually raised so that the land is submerged less often by water. The high spring tides flood in to deposit seeds and nutrient-rich silt, but neap (minimum) tides allow a breathing space for germination and the establishment of a greater variety of plants, such as sea lavender, thrift and sea aster.

Given time, and the accumulation of more silt, the oldest part of the marsh raises itself above the reach of all but the highest spring tides. Here the vegetation is dominated by grasses, reeds and rushes. The topmost levels taste salt water only at the extreme high tides of the spring and autumn equinoxes. This part of the saltmarsh is now well on the way to becoming dry land, and will have spent at least one hundred years developing.

At this stage, when nature has already done most of the work, it is an easy matter for man to keep out all tidal water with a sea wall, allow rain to wash away the salt, and so reclaim the fertile land for agriculture.

Creeks and pans The lower, younger marsh is inundated by salt water at most tides, with a gradual decrease in flooding towards the upper marsh. The zones of vegetation that reflect these environmental differences are threaded by creeks and channels and dotted with salt pans that form distinct habitats within the saltmarsh.

As the tide floods in over the mud it often becomes channeled by small irregularities such as tones or clumps of vegetation. The last of the receding tide leaves by these same runnels, and so a pattern of drainage is begun. The water is deeper in the runnels and therefore flows relatively swiftly in the embryo creeks, with a scouring action that perpetuates the pattern until deep-cut channels cross a mature, plant-rich marsh.

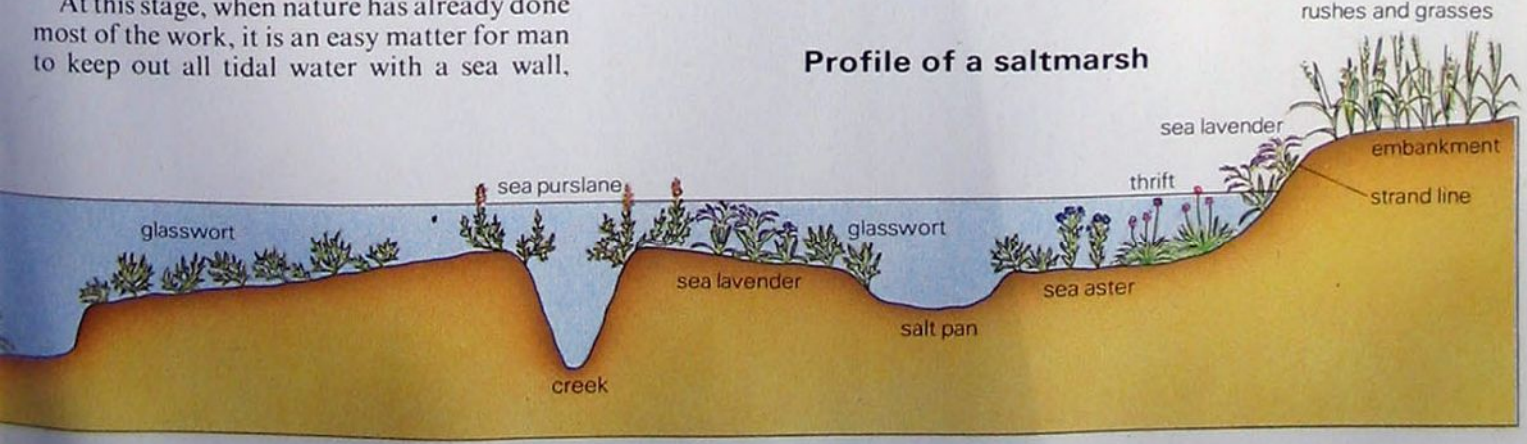
The creeks cut across the plant zones, displaying their own particular kind of vegetation. Creek sides are often near-vertical and here algae like *Vaucheria thuretti* cling on by means of a gelatinous secretion. On creek banks the characteristic plant is sea purslane, a bushy perennial that way-marks the channel course with its neat, grey-green leaves and small yellow flowers. Demanding good root drainage, this plant flourishes on the banks that are raised a little above the adjacent marsh.

These creeks often become blocked. Banks

Above: Salt pans such as these develop when a creek becomes blocked and the salt water cannot drain away. Evaporation makes the pans more and more salty until no plant or animal can survive. Heavy rain in autumn and winter may, however, help to decrease the level of salinity.

Right: This ragworm is one of the many small creatures living in the mud at the edge of the saltmarsh. It is eaten both by fishes and birds.

Profile of a saltmarsh



may slump and collapse, or a vigorous clump of cord grass may fill the channel. In such instances, the section of the creek above the blockage will probably develop into a salt pan. This cut-off creek receives an extra dose of salt water every time the spring tide, which floods the whole marsh, fails to drain through its accustomed channels. Conditions become more and more saline as evaporation begins, until all plant life is banished. On the bare salt mud the tiny *Hydrobia* snail survives, but few worms or molluscs of the mudscape remain.

Seasonal changes and rain decrease salinity for a while and gradually salt-tolerant plants like glasswort start the cycle again–a new saltmarsh succession on the pan.

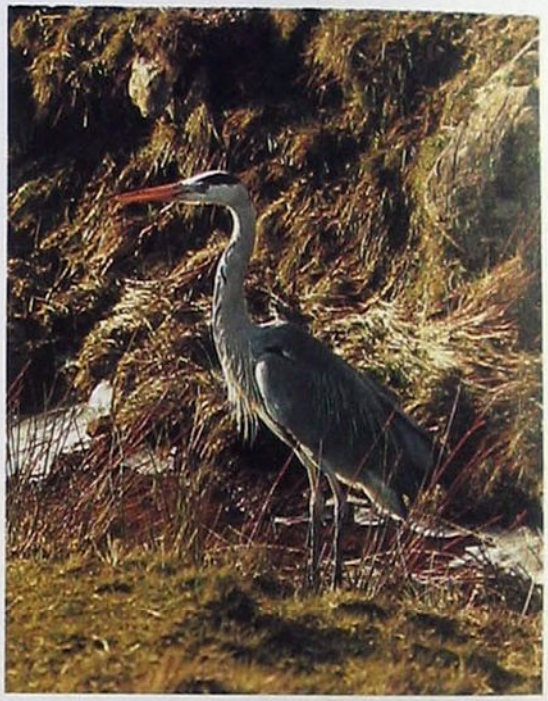
Animal movements Although distinct sub-habitats emerge in the general formation of a saltmarsh, the regular flooding unifies the whole area. The plants are adapted to tolerate salt water one day, sun and rain the next, but the animals cope with the changing conditions by moving about.

Birds, for example, seem the very essence of the remote saltmarsh landscape. It is no place for them to breed–the mute swans that attempt it often find their nests washed away or their eggs chilled by the rising tide–but at other times of the year the saltmarsh is a haven for feeding and roosting. Waders, curlews and godwits, for example, which feed in earnest when the low tide reveals protein-packed mud flats, roost on the more stable saltmarsh during high water. Wild ducks, such as wigeon, are sustained in winter by the quantities of seeds washed in at high tide, finding and eating them when the tide falls back.

Birds may be the most obvious and easily seen animals, but many other creatures also live on the saltmarsh, their lives governed by the tides. The numerous insects (especially grasshoppers and bugs) and spiders living among the plants are the same species as those on the adjoining land–they have no special adaptations–so when high water threatens they must escape by climbing up stems, swimming, walking on the water, or flying. Those that fly are often caught by swallows and martins on fine summer evenings. The dead bodies of those that fail to escape join the debris washed in and deposited by the tide.

When the debris is concentrated along a strandline, it is worth investigating for the many shells, cases (shore crabs abound), seeds, pellets, and plant and animal remains of all kinds that tell so much of the life of the surrounding waters. This material is picked over by visitors to the strandline–scavenging creatures like gulls and rats. Other mammals, too, visit when the tide is right. Rabbits are common grazers, eating grass and cutting short the strip-like leaves of sea plantain, and foxes, hedgehogs, grey squirrels and mink are not uncommon hunters on our saltmarshes.

Above: A mass of *Hydrobia* snails exposed at low tide in an estuarine saltmarsh. The green shore crab in the centre of the picture is a scavenger and will eat almost anything edible that it can find.



Right: The grey heron, which fishes estuaries and shores, moves on to the saltmarsh at high tide to roost and preen. The regular flow of the tide precludes any attempt at nesting.

Below: The banks of a drainage channel allow a variety of plants to gain a roothold. The sea purslane and glasswort growing here are both salt-tolerant–as they must be to survive.

THE SECRETIVE SMOOTH SNAKE

The smooth snake is Britain's rarest and shiest snake. Much about its behaviour is still shrouded in mystery, even though it was discovered over a hundred years ago.

Some visitors to the countryside are familiar with the adder, and a few have had a fleeting glimpse of the more elusive grass snake. But Britain's third native species of snake, the smooth snake, is a much rarer animal.

The smooth snake was not known to exist in Britain until the middle of the last century when, in 1853, one was discovered near the New Forest. By the turn of the century the smooth snake had been found in several parts of southern England, and this still seems to be the extent of its distribution in the British Isles. On the Continent it occurs in various countries from southern Scandinavia to as far south as Italy. In all these countries, and in Britain, the smooth snake is a protected species.

Soft, smooth scales The name 'smooth' refers to the snake's scales. These are characteristically soft and smooth, compared with those of the adder and the grass snake, which feel much harder and rougher to the touch.

The colour of a smooth snake is variable, but it is usually brown, reddish-brown or greyish, with a series of small dark spots and blotches extending down the length of its back and tail. A dark stripe along the side of its neck extends across the eye to the nostril. The male and female are similar, except that the male's tail is longer and thinner. Sometimes the male has an orange or red throat.

The smooth snake is noticeably more

Above: The smooth snake is the rarest snake in Britain and is a protected species. It is confined to central southern England, the best places to see it being woodland and heathland in Hampshire, Dorset and Surrey.

Smooth snake (*Coronella austriaca*). Length 50-60cm (20-24in), occasionally up to 75cm (30in).

Above: A family of newly born smooth snakes. The young are born in late summer, between four and ten to a litter.

Left: The head of a smooth snake has a distinctive dark blotch on the top, a characteristic shared by both the adults (shown here) and the young (see above). the blotch is shaped roughly like a coronet and accounts for its generic name of *Coronella*.

slender than the other two British snakes and, because of this, it is often confused with the slow-worm, especially as it has roughly similar colouring. The smooth snake, however, is larger – 50-60cm (20-24in) long against the slow-worm's length of about 45cm (18in).

Where to see them The natural habitats for smooth snakes are woodland and heathland. During the day they spend a lot of their time wholly or partly concealed among the vegetation, and it is usually extremely difficult to see them. Warm sunny days during April or May, particularly when rain has moistened the ground, is a good time to see smooth snakes, since this is when they like to bask on top of heather. They can often be approached without being disturbed. Some smooth snakes may also be seen basking on sandy banks or on small areas of bare ground between patches of heather. Mid-morning is the best time of day to look for them; in the afternoon they are less easy to find but, during the evening, they may emerge into the open to bask again, especially during a moist summer's evening.

Although smooth snakes are difficult to find, their cast skins, called sloughs, provide a clue to their whereabouts. Sloughing occurs at least twice a year, and the cast skin of a smooth snake has the characteristic smoothness that distinguishes it from that of other snakes.

Unlike the adder, which migrates from a wintering site to a summer breeding habitat, the smooth snake stays in the same area throughout the year. In one study in which the researchers managed to identify individual smooth snakes, it was discovered that they confined their movements to a well-defined area 55-65m (180-210ft) across – their home range. In partially forested areas they kept within an area of about three hectares (7½ acres) throughout the summer, but in open areas of heathland they remained within one hectare (2½ acres).

Feeding habits Until recent studies were conducted, many aspects of the smooth snake's behaviour were shrouded in mystery – including its feeding habits. It used to be thought that the smooth snake fed mainly on sand lizards, but a close study has shown that it eats an unexpectedly large number of nestling small mammals. Shrews and field mice were eaten by smooth snakes far more often than were lizards, among which the common lizard was more often consumed than the sand lizard. It seems that newly born smooth snakes feed mainly on common lizards, which they can catch extremely quickly. But as they grow their diet seems to change to small mammals.

The smooth snake appears to have two sorts of feeding behaviour. If a lizard is encountered while the smooth snake is moving about, the smooth snake takes the opportunity to seize it. Alternatively, and probably more often, the smooth snake searches for the burrows of small mammals, enters them and feeds on its prey underground. This habit helps to explain why the smooth snake appears to be such a secretive creature.

The breeding season As early as February, but more often in March, smooth snakes leave

Below: A typical habitat in which to find a smooth snake. Mid-morning on a warm sunny day in early spring is a good time to look for smooth snakes, since they are likely to be basking out in the open.

their wintering sites where they have been hibernating, and are ready to begin the new breeding season. The males locate the females by detecting and following a chemical trail left by them. Mating occurs in April or early May; the females usually mate only every other year.

The young develop in eggs carried inside the mother, but they are born live. The gestation period lasts for between 75 and 96 days, so that the young emerge any time after the end of August. Small female smooth snakes give birth to four or five young, whereas older or larger snakes bear up to ten young.

The newly born smooth snakes are soft and smooth to the touch and about 15cm (6in) long. They grow quickly during their first few years and, by the time they are three years old, they are about 32cm (13in) long.

Smooth snakes hibernate in late September or October, taking over a disused rabbit or mouse burrow for the purpose or sometimes simply burying themselves in loose soil.

Undiscovered secrets Despite recent research, we still know very little about the smooth snake. Why was it not discovered in England sooner and why is it confined to southern England? Perhaps it was introduced accidentally from the Continent during the middle of the 19th century–a few snakes could easily have been brought across unwittingly in one of the many small boats that were ferrying cargo at that time. Its present scarcity may be due to competition from the adder, or it may be due to predators, although very little is known about which animals prey on it.

Little also is known about their survival from year to year. They seem to live for as long as 12 or 14 years, although a few very large specimens have been found, which suggests that they can live for much longer. Very few one- and two-year-old smooth snakes are ever found, so it is possible that many die before they reach maturity. Smooth snakes of all ages seem to be susceptible to sudden spells of cold weather during spring when they have come out of hibernation.

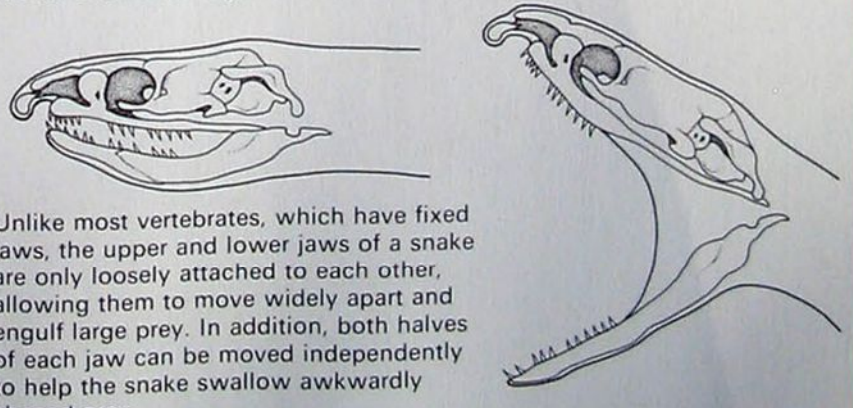
How rare are they? With many animals it is a fairly straightforward matter to determine their populations, but not so with the smooth snake. Its secretive nature makes its numbers very difficult to judge. But, as more and more is learned about the behaviour and habits of the smooth snake, so new colonies are discovered. It now seems that there are far more smooth snakes in our countryside than was once thought possible.

Above: The smooth snake is a good climber and it is not unusual to see one entwined around the lower branches of a tree.

Opposite: Because of the smooth snake's slender appearance and variable colour it is often confused with the slow-worm. Both vary in colour from grey to brown but the smooth snake has the distinctive coronet mark on its head and dark blotches running down its back.

Below: Small nestling mammals such as shrews and mice make up the major part of the adult smooth snake's diet. To cope with such large prey it has specially adapted jaws.

How a snake's jaw works



Unlike most vertebrates, which have fixed jaws, the upper and lower jaws of a snake are only loosely attached to each other, allowing them to move widely apart and engulf large prey. In addition, both halves of each jaw can be moved independently to help the snake swallow awkwardly shaped prey.

BRITAIN'S WILD 'ROSE-TREES'

Britain's wild rhododendrons are at their most beautiful in spring when they burst into flower – indeed, the word 'rhododendron' comes from the Greek for 'rose-tree'.

Above: *Rhododendron ponticum* is naturalised in the Derbyshire Dales. The shrub can grow in the open but it prefers sheltered sites, such as woodland. This is because its flowers are easily damaged by frost and by being warmed too quickly by direct sunlight.

Rhododendron ponticum. Evergreen shrub native to eastern Turkey. Introduced to Britain in the 18th century and now naturalised. Height to 3m (10ft).

Below: Young rhododendron leaves unfurling. The new season's leaves appear in May, before the flowers open.

Ever since the rhododendron was first introduced to Britain more than two hundred years ago it has been one of our most popular shrubs, especially for its beautiful showy flowers that open in spring. Today, more than a hundred species of rhododendron have been introduced to Britain but only two of these have become naturalised to any degree – *Rhododendron ponticum* and *Rhododendron luteum*. The first of these to appear in this country, and still the most common rhododendron in the wild, is *R. ponticum*.

Eighteenth century arrival *R. ponticum* was discovered around eastern Turkey, in the area now known as Armenia but which used to be called Pontus – hence *ponticum*. The shrub was introduced here several times during the 18th century and, by 1780, was on sale in nurseries. It was soon widely planted in woods to provide cover for game before being superseded during the following century by other more brightly coloured rhododendrons from Asia.

It was soon discovered that this species of rhododendron flourished in open woodland and it quickly became naturalised in this country. In fact, it proved to be invasive, spreading by means of suckers and seeds. Burnt ground and fire-breaks are rapidly colonized, and rhododendron seedlings appear in profusion on soil that has just been prepared for a new conifer plantation.

To make matters worse, once *R. ponticum* is established it is almost impossible to eradicate. Weedkillers have no lasting effect because the mature bush regenerates from its stem, even though its branches and foliage have been killed. Digging the plant out is a waste of time because the smallest piece of root left in the ground grows again to form a new seedling. It is not surprising that this rhododendron is so unpopular with foresters, for it monopolises the undergrowth of a wood and prevents other saplings from growing.

Evergreen leaves Identifying *R. ponticum* is easy, especially in winter because most shrubs are bare at this time of year whereas *R. ponticum* is evergreen. It is a large shrub, reaching as high as 3m (10ft), with a multitude of greyish woody stems joined at the base. The leaves are elliptical and large – 6-12cm (2½-5in) long. They are dark green above and paler green below; like so many other evergreen leaves, they have a leathery texture. They are arranged spirally around the tips of the twigs, each leaf being positioned so that it receives the maximum amount of sunlight.

The flowers open in May or June on compact racemes. Each purple flower is about 5cm (2in) in diameter. The fruit consists of a capsule about 1.5cm (⅝in) long and usually divided into five sections that split to release numerous small seeds.

Hybrid rhododendrons Few specimens of *R. ponticum* originate from the pure species. Most are hybrids between *R. ponticum* and one of two other species – *R. maximum* and *R. catawbiense*. These two species are closely related to *R. ponticum*, even though they are both native to North America. The former species was introduced during the 18th century and the latter during the century after.

It is often possible to determine the par-

Above: The flowers of *R. ponticum* appear in May and June, clustered in large flowerheads known as racemes. Each flower is purple or pinkish-purple with brownish (sometimes greenish) spots inside. At its centre are ten stamens—tipped white here—and a single pistil tipped pink or orange.

entage of a particular hybrid bush from details of its floral structure. For instance, the three species have quite different ovaries, those of *R. ponticum* being hairless, those of *R. maximum* being hairy and those of *R. catawbiense* being covered in a brown felt-like material. By examining the ovaries of a hybrid bush it is often possible to tell which species were its parents.

The flowers differ in structure for, although they are all purple or pinkish-purple, they have greenish or brownish spots on *R. ponticum*, and yellow spots on *R. maximum*. There are also differences in the shape and size of the bush. *R. catawbiense* grows to the same height as *R. ponticum* (3m/10ft) but it is a much broader shrub, being especially prone to suckering to form dense thickets. *R. maximum*, on the other hand, is much taller than either of the other two species and can reach a height of 9m (30ft).

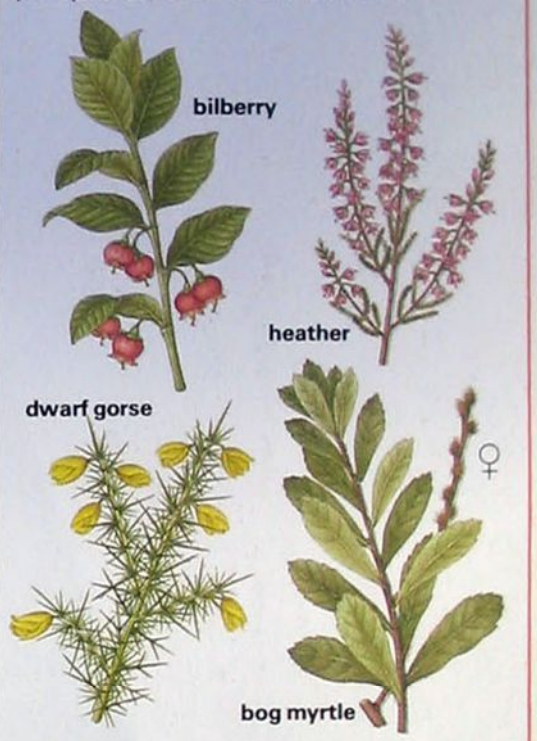
Yellow-flowering rhododendron Although the *ponticum* hybrids are by far the most common form of naturalised rhododendron, another very different species has managed to establish itself in some areas of the country. This is *Rhododendron luteum*, a deciduous shrub with stiff branches that grow to a height of 3m (10ft). The leaves are bluish, slim and pointed and about 5-13cm (2-5in) long. The flowers are bright yellow and very fragrant. They open in May before the leaves appear. The shrub is particularly attractive in autumn, when the leaves turn red, orange or purple.

This rhododendron was introduced to Britain from the Caucasus Mountains at the end of the 18th century. It is still widely cultivated and used in hybridisation since it is much hardier than many other species of rhododendron. Weak-growing azaleas are often grafted on to its rootstock. This has helped *R. luteum* to spread, since suckers growing from the rootstock are frequently stronger than the hybrid. A similar effect occurs with *R. ponticum*, since it too is used for rootstocks. More than one neglected garden, which was once a riot of colour from different rhododendron hybrids, is now swamped with yellow *R. luteum* and purple *R. ponticum*.

Acid-loving plants

Many plants grow well only on an acid soil; on a chalky, alkaline soil they fail to develop a proper root system and die. Such plants include bog myrtle and gorse, but the most familiar examples are the members of the heather family (Ericaceae), which include rhododendrons, bilberry and heather itself.

Experiments have shown that it is the alkalinity of the soil (ie its high pH level) rather than the high concentration of calcium from the chalk that kills the plants. It seems that, as the pH of the soil increases, acid-loving plants become incapable of extracting certain vital elements, such as potassium, iron and phosphorus, and die of malnutrition.



Below: A rhododendron bush in its preferred habitat of open woodland. The evergreen leaves of rhododendron form an impenetrable cover year-round, blocking out the sunlight from anything that attempts to grow beneath.

THE CURLEW AND ITS COUSIN

The curlew (above) is a common British wading bird, while its relative the whimbrel is scarce, being chiefly a bird of the Arctic. But you may see whimbrels flying past on their migratory flights to Africa in autumn, and on the way back in spring.

Curlew (*Numenius arquata*).
Largest European wader. Resident, breeding in moorland, grassland, marshes and dunes. Winters on estuaries and coasts. About 50,000 breeding pairs. Length 53-58cm (21-23in).

Whimbrel (*Numenius phaeopus*).
Summer visitor, smaller than curlew. Breeds in dry moorland and grassland in north Scotland and Shetlands. Under 200 breeding pairs. 41cm (16in).

The curlew is a truly unmistakable bird: a large, robust wader, common on estuaries in autumn and winter, and familiar in the west and north as a breeding bird of inland pastures and hayfields in spring and summer. Its silhouette, with long legs, slightly hunched attitude and long, curved bill is unlike that of any other bird except for the whimbrel which, although it looks similar to the curlew, is rarely seen in Britain. Look closely at the curlew and you will see that its strong legs are a delicate pale grey, while the plumage is a warm ashy brown, paler below, and streaked with darker brown on the neck and upperparts. Like other large waders it has a long neck, but the most remarkable feature is the surprisingly long, downward curving bill.

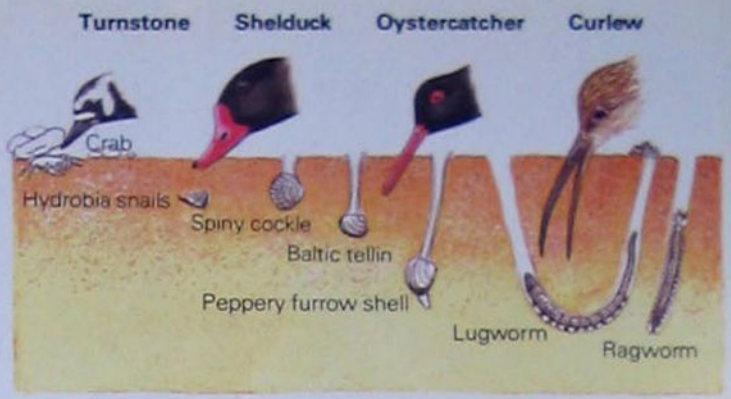
On the wing, curlews are bulky birds with strong, steady flight, less rapid than most other waders and looking a little like gulls at a distance–even in their habit of dropping down to their feeding grounds on estuaries in a long, planing glide. They are shy and wary birds, whose measured, dignified movements set them apart from the scuttling activity of the mass of other waders on the shore.

Introducing the whimbrel The much scarcer, but less timid, whimbrel is superficially similar to the curlew, but the main differences are a shorter and less curved bill, shorter legs and a distinctive pattern of two dark bands of feathers on the crown. In general, it is a slightly darker and smaller bird than the curlew, although if it were not for the simple and distinctive call of the whimbrel it is probably fair to say that a great number of individuals passing through on migration would go undetected.

Whimbrels are essentially birds of passage in Britain, and so if you hear the sound of a whimbrel at all, it is likely to be flying overhead, giving its presence away by a call of about seven rapid, whinnying notes. Whimbrels stay to breed only in small numbers, chiefly in the north of Scotland and the Shetland Islands. In their northerly habitat they replace the curlew, which is a bird of the temperate zone. They breed chiefly in the Arctic zone all round the northern hemi-

How shore birds share their prey

The many birds that feed on estuaries and mudflats do not all compete for the same food. The curlew and the whimbrel can locate deep-burrowing creatures with their long, sensitive bills. For shorter-billed species of birds, such as shelduck and oystercatcher, there are shallow-burrowing shellfish, while turnstones and gulls feed on surface-dwelling crabs and mussels.



Far right: Adult curlews incubate their eggs for just over four weeks and the young hatch at about the end of May. The curlew and whimbrel, in common with other large birds, have only one brood per year, but lay a replacement clutch if the first one is lost.

Below right: Curlews lay four green-brown eggs, which are large and strongly pointed. The chicks have short beaks, which grow rapidly during fledging.

sphere. They nest on dry moors and old peat hags (mounds), and although much of this habitat exists in northern Scotland, the whimbrel remains a very scarce breeding bird in Britain, which lies at the southern limit of its breeding range. Fewer than 200 pairs of whimbrels breed in Britain each year.

The curlew in spring The return of the curlew to its nesting fields is one of the unfailing signs of spring. There are few sounds that are more welcome at the end of a long winter than the strident, bubbling song of the curlew. The song begins with a series of slow, graceful notes and then gains momentum, strengthening and rising in pitch to a rapid trill before descending again in a series of

Above: A whimbrel nesting on Fetlar, one of the Shetland Islands, makes contact calls to its 12-hour old chicks.

Left: A curlew balances in a typical one-legged posture while it rests and preens its plumage.

Below: Whimbrels prefer dry upper moorland as a nesting area. They also choose sites on the dry mounds left by the erosion of numerous small streams on peat moors.

low, single notes. This song is performed during a beautiful song flight in which the bird rises high with trembling wings and then descends in a shallow, gliding plane.

Curlew migration In the south of England, curlews begin to arrive in their nesting areas as early as the last days of February, but it is usually well into March before those that breed in Wales, northern England and Scotland reach their strongholds in the hills and valleys. Often at this season the birds can be heard calling at night, as they follow the river valleys up to the foothills. At one time curlews were thought of exclusively as birds of upland moors, but in the last 50 years or so there has been a sharp increase in Britain's curlew population, together with a marked spread into the lowlands. Now the curlew is as familiar in some lowland areas as in the uplands. There are probably about 50,000 pairs in Britain and Ireland.

Curlews are comparatively short-distance migrants: the main British population leaves the breeding areas in July, but travels no further than our own coasts. Many of the curlews of Europe's mainland, too, escape the Continental winter by flying across to Britain's coasts. However, a particularly severe British winter is also a threat to the curlew, so that even here they may not be out of danger.

Whimbrel migration Whimbrels on the other hand, like many of the species which migrate to the Arctic to breed, are among the great long distance travellers. At the end of the short breeding season they journey south, stopping to find nourishment on the estuaries in western Europe. Most travel in August, and by October the movement has finished except for a few stragglers. They have far to go–the majority seek the fertile tropical shores of West Africa, and some even go as far as South Africa. In spring the same movement occurs in reverse, most birds travelling up the coasts of western Europe in late April and May. Relatively few touch down in Britain, but the bulk of those that do use the low wet meadows of the Somerset levels as their main staging post.

Following the tide Outside the breeding

season, both whimbrel and curlew share the mudflats and estuaries with hordes of other wading birds. Their activity is linked with the ebb and flow of the tides, both by day and by night. As the rising tide covers the feeding grounds they fly to the quiet of a safe roosting site; as the tide ebbs again, they rise and follow it down, feasting on the harvest left behind by the tide. The curlew searches deeper than any of the other waders, and the whimbrel searches deeper than most. The tips of their bills are highly sensitive and enable them to feel the lugworms and ragworms in the sand. Both species also eat crabs and the smaller crustaceans, and small shellfish.

Life in the breeding grounds After flying inland to their breeding grounds, both whimbrel and curlew change to terrestrial habits of feeding. In this habitat of fields and moorland, they continue to use their bills to probe into the ground, where they find earthworms–although there are less of these to find on the moors than in grassland. Most of their food is taken from the surface of the ground, in the form of insects and their larvae, spiders, woodlice and other invertebrates. They also feed on the vegetation, including berries.

While the conspicuous song flight makes the curlew's breeding territory easy enough to locate, the nest itself is much more elusive. The birds become very secretive once they have laid their eggs, slipping off the nest and moving away through the grass long before an intruder comes near. The eggs are laid in a scant nest of grasses, well concealed in a deep tussock or in other rough vegetation, such as standing hay.

In those areas where the breeding areas of the curlew and the whimbrel overlap, for example in the Shetland Islands, the separation between the two is clear: the curlews inhabit the hay meadows and water valley bottoms, and the whimbrels resort to the upper areas of dry moorland. The picture becomes confused as the season advances, for then the whimbrels lead their young down to feed in the lower valleys. Once the eggs hatch, or towards the end of incubation, the adults become much more conspicuous and noisy if approached. They defend their brood boldly against crows, birds of prey, foxes, dogs or other ground predators. Parents often divide a brood between them, and go separate ways–increasing the chance that at least one group will come safely through the vulnerable weeks of fledging. Once on the wing, the families reunite before leaving the breeding grounds.

Hopes of protection Until the recent passing of the Wildlife and Countryside Act (1981), curlews and whimbrels were both legitimate quarry for shooting. The new Act gives total protection to both at all times of year, and the whimbrel, one of our scarcest breeding birds, is additionally protected by special penalties.

Above: A flock of curlews in the sea, with several oystercatchers and a shelduck. Both curlews and whimbrels are gregarious in winter, and flocks on large coastal flats can run to thousands.

Below: The curlew breeds in most parts of Britain and Ireland. The extreme north of its range overlaps with that of the whimbrel, while in the Arctic zone the whimbrel replaces the curlew altogether.

WEEVILS: A VEGETARIAN LIFE-STYLE

Originally denoting almost any kind of beetle, the name weevil is now used for the 500 species of the family Curculionidae. Many are brightly coloured and all are vegetarians.

Most weevils are recognisable by the fact that the head is well drawn out into an elongated, beak-like snout, at the tip of which are situated tiny jaws. This elongation, called the rostrum, bears a pair of elbowed and somewhat clubbed antennae. In many weevils the antennae can be folded for protection into grooves at the sides of the rostrum.

Weevils are found on many kinds of plants, some being highly specific to their host-plant. According to their way of life, they may be leaf rollers, stem borers or bud eaters, and they may burrow into fruits and roots or just eat parts of the leaves. In fact, there is hardly any part of a plant that some leaf weevil will not eat. Because of this diet it is not surprising that some weevils are notorious pests of crops, and sometimes of stored food as well. Here we describe several species from four of the 26 British sub-families of weevils.

The leaf rollers The red oak roller, one of our larger weevils, is a conspicuous red colour, except for its legs and head which are black. The female is about 6mm ($\frac{1}{4}$in) long, while the male is slightly smaller. This species lives mainly on the foliage of young oaks and is rarely found on mature trees. The conspicuous coloration is a warning, indicating inedibility or the possession of some effective weapon of defence or offence against a potential enemy such as a bird. The female lays her eggs singly on oak leaves, then rolls the leaves up to form protective homes for the larvae.

Above: The red oak roller (*Attelabus nitens*) is widely distributed in Britain, and can be found from late May onwards. This species is aptly named since the female lays her egg on an oak leaf, then rolls the leaf up to make a secure home—and provide food—for the larva. Like all weevils, this species has a hard, tough outer covering that is a useful protection against predators as well as against excessive loss of moisture.

The birch leaf roller is related to the red oak roller, but is rather smaller and of a shining dark bluish-black colour. This weevil has much the same shape as its relative, but is only 3-5mm long. Looked at with a hand lens the thorax of the birch leaf roller is decidedly hairy; the male can be distinguished by his puffed out black femora (the long leg joint nearest the body).

Like the red oak roller, the birch leaf roller is occasionally found on other trees—birch, hazel, hornbeam and alder for example. But it is essentially an inhabitant of birch woods and it, too, rolls up leaves to house its larvae. It is widely distributed and quite common in the British Isles.

A related, but larger and hairier, weevil also occurs chiefly on birch. It is called *Byctiscus betulae* and it can be a dark metallic blue, green, or shining red-brown in colour. This weevil is much more local than the other two and is commonest in the south of England. Although it is unlikely to be confused with the birch leaf roller, it can be precisely identified because the male has a small, forward-projecting spike on each side of its thorax. *Byctiscus* is also a leaf roller.

Figwort weevils There are seven species of weevils of the genus *Cionus*, all of them square in shape with a rather long rostrum on which the antennae are set well forward. The legs are short and stout, giving these weevils a

Rolling a home

The female red oak roller lays a single egg on the upper side of the midrib of a young leaf. She cuts a slit in the leaf from each side to the midrib and rolls the cut portions into a kind of tunnel, rather like a rolled up carpet. She then bites a little way into the stalk at the base of the leaf, which partly cuts off the leaf's supply of water and nutrients, causing it to turn brown. In time the leaf withers and drops off, but not before the larva has eaten the inner part of the leaf roll and turned into a pupa.

compact appearance.

Cionus scrophulariae is closely associated with common figwort, water figwort and the related common mullein. It is widespread over much of Britain. Its most distinctive feature is the light colour of its thorax, which is covered with whitish or pale yellow scales. There are also a number of square black spots on its grey wing cases, the central ones being larger than the others. The antennae are reddish with darker clubbed ends, and the legs are black with brown tips. This weevil is 4-4.5mm long and one of the largest in the genus. The thorax of the closely related *C. tuberculosus* is much the same colour as its wing cases (not lighter). This species occurs on the same food plants as *C. scrophulariae* but is much rarer.

Cionus weevils feed on the leaves of their food plants, and a number of them are usually found together. The larva is a greyish, slug-like creature, heavily coated with slime, which it produces from a gland near the end of its body. This slime undoubtedly helps to protect the otherwise rather vulnerable grub from bird predation, and especially from drying up. It is also used to form a tough cocoon, which is firmly attached to the food plant.

Inside the cocoon the pupa is well protected for the short period of a week during which it undergoes the transformation into an adult beetle, although it may be attacked by tiny parasitic wasps. The fully formed adult bites its way out, making a neat circular hole at one end of the cocoon. Ultimately it goes into hibernation at the base of a tuft of grass or among leaf litter in a hedgerow.

Fruit tree pests The apple blossom weevil is one of the best known members of its family. It is widespread in England and Wales and often very common where apples are grown. It is much rarer in Scotland and Ireland. The apple blossom weevil is a dark ashy red colour, with two broad oblique greyish stripes towards the end of each wing case–the two stripes together forming a somewhat flattened V shape.

Apple blossom weevils come out in spring from behind loose bark, leaf debris and other sheltered spots where they have hibernated. They live almost exclusively by feeding on young apple leaves, in which they make small holes. Occasionally they attack the leaves of pear trees.

The female bores a hole into an unopened blossom bud with her long rostrum, then turns round and deposits an egg into the hole. Each female lays about 50 eggs. Soon a pale grub with a dark brown head hatches and eats its way into the bud, gradually destroying it so that it turns brown and never opens. The grub then eats away the base of the flower and after about two weeks is fully grown and ready to turn into a white pupa. As with many weevils, the pupal stage is short; it takes only seven to ten days before the adult bites its way out and starts to feed on the leaves. Unlike its parents, this generation of weevils does not make holes in the leaves but rasps at their tissues, skeletonizing them with its tiny jaws. This takes place mostly during the hours of darkness.

After about a month these weevils disappear to hibernate, emerging again the following spring to feed on the leaves, this time making the familiar round holes.

Birds, especially titmice, are important predators on apple blossom weevils. The ichneumon wasp *Pimpla pomorum* parasitises both the larvae and the pupae, but the proportion of parasites is never enough to make a really big difference in a concentrated population of weevils in an orchard. After all, it is not in the parasite's interests to destroy its host. Modern control of the apple blossom weevil is effected by careful spraying with one of the organophosphorus compounds.

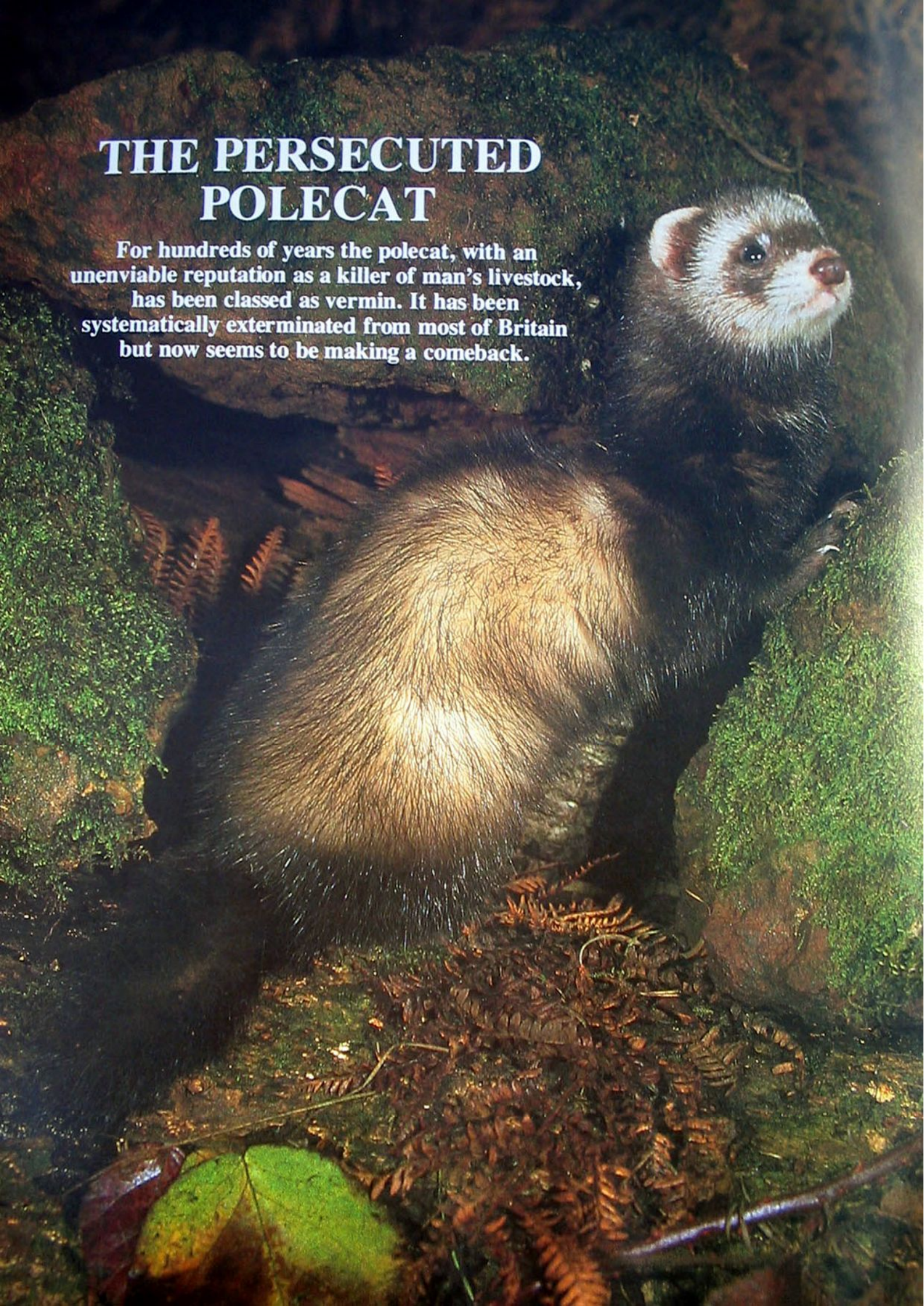
Above: *Byctiscus betulae* is a leaf-rolling weevil that can be found on hazel and poplar as well as birch.

Above: *Cionus scrophulariae* can be found on figwort and is 4-4. 5mm long. It is common throughout Britain.

Above: The apple blossom weevil (*Anthonomus pomorum*) is widespread in England and Wales and is 3-4mm long.

Above: A figwort weevil (*Cionus hortulanus*) sitting on a figwort bud. If you examine the flower heads of common and water figwort (and the related common mullein as well) in summer you will probably be surprised to find that some of the 'seed boxes' fall off easily in the palm of your hand. Pause a moment and one may expand into six legs, a rostrum and a pair of antennae and start to crawl away. It is one of the compact-looking adult figwort beetles, which are decidedly like the figwort seed boxes in appearance.

Left: This rolled up birch leaf probably contains the larva of the birch leaf roller weevil (*Deporaus betulae*, or *Rhynchites betulae* as it used to be called).



THE PERSECUTED POLECAT

For hundreds of years the polecat, with an unenviable reputation as a killer of man's livestock, has been classed as vermin. It has been systematically exterminated from most of Britain but now seems to be making a comeback.

The polecat is a member of the family Mustelidae, which also includes the otter, stoat, weasel and mink. Like the other mustelids, the polecat possesses anal scent glands which release a pungent oily musk. This is used to mark out territory and can also be released in the face of a pursuing predator – hence the polecat's other names, 'foulmarten' or 'foumart'.

The polecat has the typical mustelid body – long and slim with short rounded ears and short legs. Its coat consists of pale cream or buff underfur and longer black-tipped guard hairs which give it an overall dark brown appearance. In winter the underfur becomes denser making the guard hairs stand out at a greater angle and giving the coat a lighter appearance.

A natural variation, once quite common in central Wales, is the erythristic form. This occurs when the black pigment in the guard hairs is replaced by a red pigment.

The polecat also has a distinctive 'mask', which varies between individual animals. It is formed by pale cream or white fur on the muzzle, sides of head and ear borders, which leaves a dark band across the eyes.

As with most other mustelids, male polecats are larger than the females – sometimes they can be up to three times as big.

Varied habitat There is no typical polecat country for these animals occur in a great variety of places. Polecats have been found living in woodland, open mountain, moorland, pasture, bog, hill valleys and coastal regions. In fact, polecats have been recorded in Britain from sea-level to 520m (1700ft) above sea-level, and any habitat which provides suitable prey can harbour polecats.

They are often found around human habitations, especially farm buildings where they seek refuge beneath hedges and walls or even under the buildings themselves.

Underground homes Polecats live in burrows, either excavating them themselves or 'squatting' in a hole vacated by another animal. The burrow has several entrances to make escape easy, and is wide enough for the animal to move through at speed and turn around. Leading off the main tunnel is a side chamber which is used for sleeping and resting and also as a larder for storing food. Only one burrow is used for sleeping in, but around the home territory the polecat may also excavate a series of bolt holes and additional food stores. Polecats are very clean animals and from time to time bedding material from the sleeping chamber is brought to the surface for airing.

A solitary existence For most of the year the polecat is a solitary animal, keeping to regular paths and runways within its own territory. Rocks, stones and tree stumps are marked at regular intervals with droppings or fluid from the scent glands.

Polecats seldom attack an intruder in their territory very violently – except during the breeding season. Out of the breeding season, the territory owner follows the intruder, jumping onto its back to give it warning bites, and sniffing and leaping around it. When the intruder has completed its 'tour' of the area it begins to show an interest in the owner, sniffing at its anal region and performing a characteristic 'dance' which includes jumping into the air with all four feet off the ground and opening and closing its mouth. Gradually the distance between the two animals is increased and the intruder leaves.

In the breeding season, encounters between male polecats are much more aggressive, with vicious fights that last for up to ten minutes. During these fights the polecats become so engrossed with one another that dogs have been known to approach unnoticed and kill both contestants.

Hunting habits It is difficult to observe polecats in the wild, for they are normally nocturnal hunters. They leave their lairs early in the evening to hunt prey which includes small and medium sized mammals; small

Making a comeback?

Once widespread in Britain, the polecat population was depleted by man. By 1950 the only remaining stronghold was an area around Aberystwyth, in Wales. Then in the mid 1950s the polecat began to extend its range. At this time myxomatosis caused a decline in commercial trapping, and predators such as the polecat, which had previously been trapped to prevent them eating snared rabbits, were no longer under threat from gamekeepers. At the same time the use of gin-traps was banned. The polecat is once again found throughout Wales and is extending its range into the English border counties.

Opposite: Polecats live in underground lairs, either taking advantage of an old rabbit burrow or using their forelegs and webbed hind feet to excavate a burrow themselves. Often the entrance to a burrow is constructed below a natural feature of the landscape, such as a tree root or a large rock.

Below: The polecat family breaks up when the young polecats are about three months old, but groups of two or three of them can sometimes be seen together as late as October. They show no hostility towards one another and remain sociable right up to the separation. These youngsters are sharing a starling between them.

birds and their eggs; frogs, toads and eels; and reptiles, including adders. Invertebrates and carrion form a secondary part of their diet.

The polecat has a fierce temperament and can kill animals larger and heavier than itself, such as hares. A female will not hesitate to attack dogs or even a man if her young are threatened.

The polecat stalks its prey using its acute night vision and highly developed senses of hearing and smell, then seizes it with powerful canine teeth and jaws. If the victim is not killed immediately, the polecat shakes it from side to side until the neck is broken. The polecat kills larger prey by piercing the throat or skull with sharp teeth.

Food is either eaten straight away 'on site' or in one of the polecat's burrows, or is taken to a larder and stored, where it may remain fresh for some time. Large amounts of food may be left in these stores, but some of it may be forgotten and left to decay. In one hoard, a polecat had managed to accumulate 120 frogs, all bitten at the base of the head and so paralysed for storage.

Above: There are up to 12 kittens in a litter of which only about half will survive to weaning. The sparse white baby fur is replaced by a dark coat when they are three weeks old and within 50 days they have the characteristic polecat appearance and facial markings shown here.

Below: The polecat is a poor climber and although it can make its way up a tree, it finds returning to the ground difficult. Most of its life is spent on the ground.

Family life In March or April the male polecat or 'hob' turns his attention to the female or 'jill' and the four month breeding season begins. Courtship is a violent affair, with the male seizing the female by the scruff of her neck and dragging her into undergrowth or a burrow where mating takes place. Often the male loses his grip and the female runs away, to be caught again a short distance away. Courtship is accompanied by many excited squealing and clucking noises. Polecats are solitary animals and after mating male and female go their separate ways, hunting entirely by themselves.

Pregnancy lasts for 42 days, during which the female makes a new spherical nest of leaves and grass in her burrow. Into this warm environment are born up to 12 pink, blind and deaf young, called 'kittens'. Of these only about half will survive to weaning. It is thought that any weak or unhealthy kittens that do not die naturally are killed by the mother. Only one litter is produced each season.

Learning to hunt The young leave the nest burrow to begin hunting with their mother at about two months old. When out together, the family party forms a column, the mother leading and the kittens following her, nose to tail. The young stay very close at all times and watch her hunting technique. If an enemy should threaten her young, the mother defends them with great bravery, showing her teeth and hissing before launching an attack.

Like other mustelids, polecats are extremely playful creatures, especially when young. The kittens indulge in games of mock attack, wrestling, hide-and-seek, and in the nest they fight and have tugs-of-war over small prey their mother has brought back from her solitary travels in search of food.

POLECAT (*Mustela putoris*)
Size Head and body length 32-44cm (12½-17½in); tail 13-18cm (5-7in); weight, males 0.8-1.4kg (1¾-3lb), females 0.3-0.7kg (¾-1¾lb).
Colour Dark—extremities almost black. Summer coat looks darker than winter coat due to moulting of pale underfur. Distinctive dark mask over eyes.
Breeding season March-August.
Gestation 42 days.
No of young 5-12, only 4-8 survive to weaning.
Lifespan Max 4-5 years.
Food Carnivorous: small mammals, birds, lizards, snakes, frogs, invertebrates, some carrion and birds' eggs.
Predators Man, fox and dogs.
Distribution Once widespread in Britain, now only Wales and border counties.

FLOWERS OF THE SHINGLE BEACH

Flowers that grow by the sea must cope with exposure to wind and salt spray. Those living on shingle beaches also have to adapt to shifting shingle and lack of nutrients; nevertheless, several species manage to flourish under these conditions.

Above: The sea campion in bloom. This plant thrives on shingle, even in the winter when storms drive the seas high up the beach to inundate the normally fresh water levels with salt. The whole beach moves as the pebbles are shifted by the sea, and plants are often buried completely by sand or shingle. Species such as the sea campion seem to flourish under this periodic burial and grow with renewed vigour, producing many new shoots.

The number of different species of plants found on shingle foreshores is limited to about half a dozen species on any one beach. In fact, it is more usual to find only two or three species.

Surprisingly perhaps, it is not a lack of fresh water that makes shingle foreshores such a tough environment for flowering plants. The surface layers of shingle are actually well supplied with rain and dew, which provide a reservoir of fresh water that rests on the deeper salt water below. The pebbles seem able to hold this water on their surfaces and even in a drought the plants that live on shingle are green and fresh when inland plants may be wilted and brown. Nor does the salt spray or the exposure to wind pose any particular problem, for many plants living near the sea tolerate wind and salt, yet cannot survive on a shingle foreshore.

The real difficulty is the instability of the substrate; the constantly shifting pebbles damage many seeds and seedlings before they can grow large enough to withstand such movements. It is only after the beach has become stabilised above the high tide mark, where the sea does not cause constant movement, that large scale colonization can begin.

Early colonists Lichens such as the black *Verrucaria maura* and the yellow *Xanthoria parietina* are the first to appear, and gradually the spaces between the pebbles fill up with lichens, grit and shell fragments. A rudimentary soil begins to develop very slowly, but there is still one problem for colonizing plants–lack of nutrients. Almost the only source of organic material, apart from dead lichens, is tidal drift. This explains why the spring high tide mark, with its line of dead seaweeds, driftwood and decaying skeletal remains, is one of the best places to look for the few flowering plants that can tolerate this harsh environment. Those that do grow here often have more than one adaptation to help them make the best of the conditions.

Creeping rootstocks Complete plant cover does not form on shingle foreshores; instead, individual plants are dotted along the strand

Above: The sea kale, seen here with its fruits. Its tender shoots, which appear in the spring, have been eaten by coastal dwellers for centuries.

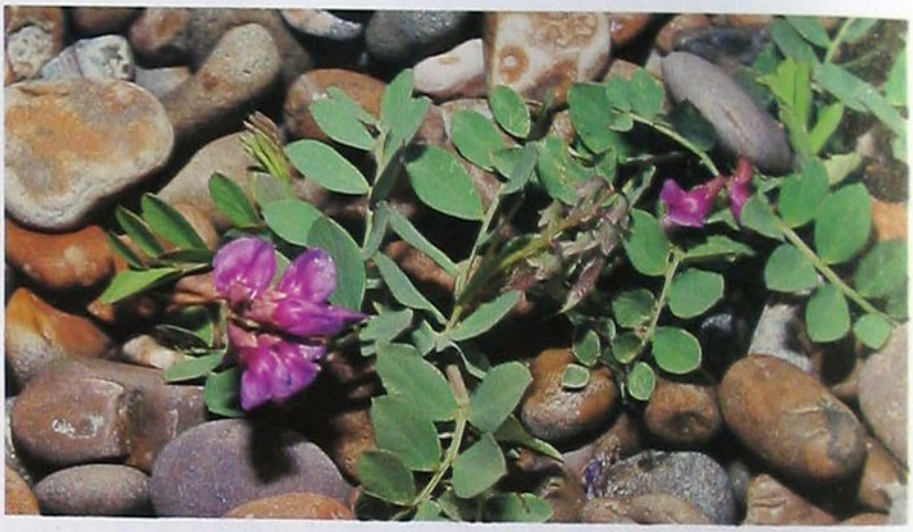
line and above the high water mark. Sea campion is one of the most widespread of such plants, growing along with sea sandwort where there is sand mixed with shingle. These are both prostrate or low growing species, pressed to the beach to avoid the worst effects of the wind. Their creeping rootstocks penetrate the shingle in all directions and anchor the plants firmly.

The sea campion forms spreading cushions of bluish leaves, and is covered with white flowers from May to July. Like many of the inhabitants of shingle beaches, it is not confined to this environment, but is rather an opportunist with an ability to survive in most maritime habitats. As a result, it is not only found on shingle foreshores, but also on cliffs, sandy banks, and at the edges of saltmarshes all round the British coastline.

The oysterplant is a northern species, growing most commonly on the south-west coast of Scotland. In former years it also grew in Norfolk and Anglesey, but it is now extinct in many of its southern localities. The root of this plant produces a multitude of white stolons (rooting, creeping stems) which grow through the shingle to produce new plants, each with several prostrate stems and large, blue-green leaves.

Root adaptations Shingle foreshore plants usually have long, tough, woody roots, well able to withstand the friction of the pebbles. Many of the species, like sea pea, sea beet and curled dock, have tap roots that delve deep into the shingle, anchoring the plant firmly while remaining within the freshwater layer.

The sea pea is locally abundant on the shingle beaches of the south coast, including Chesil Bank. It is a perennial, prostrate species, bearing purple flowers from May to August. Like the non-maritime members of the pea family, its tap root carries nodules containing nitrogen-fixing bacteria. Garden-



Above: Although the sea pea (*Lathyrus japonicus*) is relatively rare, in the areas where it does grow it may appear in large patches. Legend has it that the people of Aldeburgh in Suffolk survived a famine in the 16th century by eating the seeds of the sea pea; it still grows on the shingle beaches near Aldeburgh today.

Sea beet (*Beta vulgaris* ssp *maritima*). Flowers June-Sept on shoreline. Ht to 80cm (31in).

Frosted sea-orache (*Atriplex laciniata*). Flowers July-Sept around high tide mark. Ht to 25cm (10in).

Right: The oysterplant (*Mertensia maritima*) is a relative of the garden lungwort and so is sometimes known as the sea lungwort. It is one of the first shingle plants to bloom, producing pinkish flowers in May which turn blue as the season progresses. The blue-green leaves are sometimes dotted with white spots.

ers and farmers make use of this characteristic when they plant clover in fields and lawns; when these leguminous plants die, they leave the soil enriched with nitrogen.

In a nutrient-poor environment like a shingle foreshore, this nitrogen-fixing ability of the sea pea is especially valuable. Yet surprisingly, this does not seem to give the plant any great advantage, and it is relatively rare, appearing only on shingle foreshores in the south and south-east of England and north-east Scotland.

The sea beet, like the sea pea, is a rather straggling perennial. It is more common, growing along the driftline on both shingle and sandy foreshores around most of Britain's coastline. Its small green flowers appear in loose clusters from June to September.

The maritime variety of the curled dock has a tall flowering stem which is surprisingly sensitive to salt spray. In flower from June to August, it can be killed by a summer storm. It overwinters by retaining a rosette of dead leaves from the previous season's growth. The extensive tap root and this crown of dead leaves survive through the winter, and in spring side shoots begin to grow to replace the dead aerial parts.

Sea kale has a large, fleshy rootstock that acts rather like a tap root. It is an unusual perennial plant, growing along the driftlines of shingle and sandy beaches around the coastline. It grows much larger than many of the other foreshore plants, with large, wavy, blue green leaves and dense heads of white flowers that appear from May to August.

Water-retaining leaves Thick stalks and fleshy, water retaining leaves are among the adaptations to life on the shingle foreshore. Shrubby seablite is rather different from most of the other shingle species, being a 90cm (3ft) tall shrub rather than an herbaceous plant. It has fleshy, water-retaining branches and leaves which are blue-green in colour. The solitary greenish flowers appear in the axils of the leaves from July to October.

It grows only where the drainage is very good, so a shingle foreshore suits it well, although it also grows on the borders of salt-marshes. The seeds of this species are distributed by the sea and they germinate on the strand line when they are washed up on the beach. Shrubby seablite is locally common, Chesil Bank and certain shingle beaches in Norfolk being the best places to see it.

Another shingle-growing member of the same family, the Chenopodiacea, is the frosted sea-orache. This species takes its name from the frosted silvery appearance of the reddish prostrate stems, fleshy leaves and greenish flowers. The flowers are unisexual, male and female appearing together on the same short spikes from July to September. Frosted sea-orache is an annual species, dying away in the autumn.

Adaptations to foreshore life

Sea kale has a large **fleshy rootstock**, which anchors it firmly in the shingle and ensures that it is always in reach of the water supply.

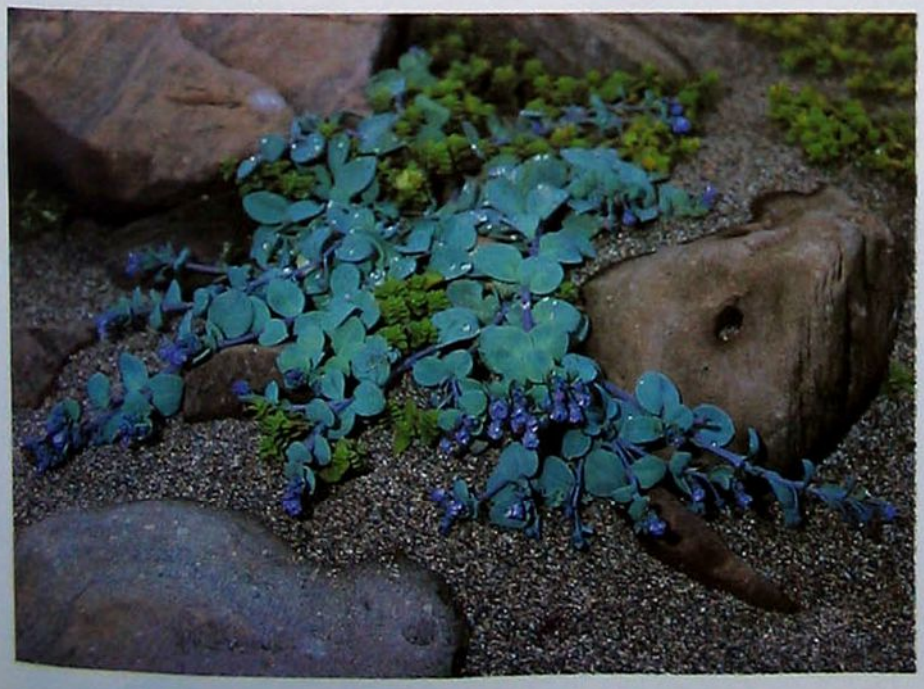
Sea campion has **creeping, sprawling stems** which hold it close to the shingle, preventing damage by the wind. As it grows in exposed places, it also has a waxy coating on its foliage to help prevent water loss.

Shrubby seablite has **small, fleshy leaves** which retain water, acting in a similar way to cacti growing in deserts.

Right: **Shrubby seablite** (*Suada vera*). Flowers July to October, above high tide mark. Ht 60cm (24in).

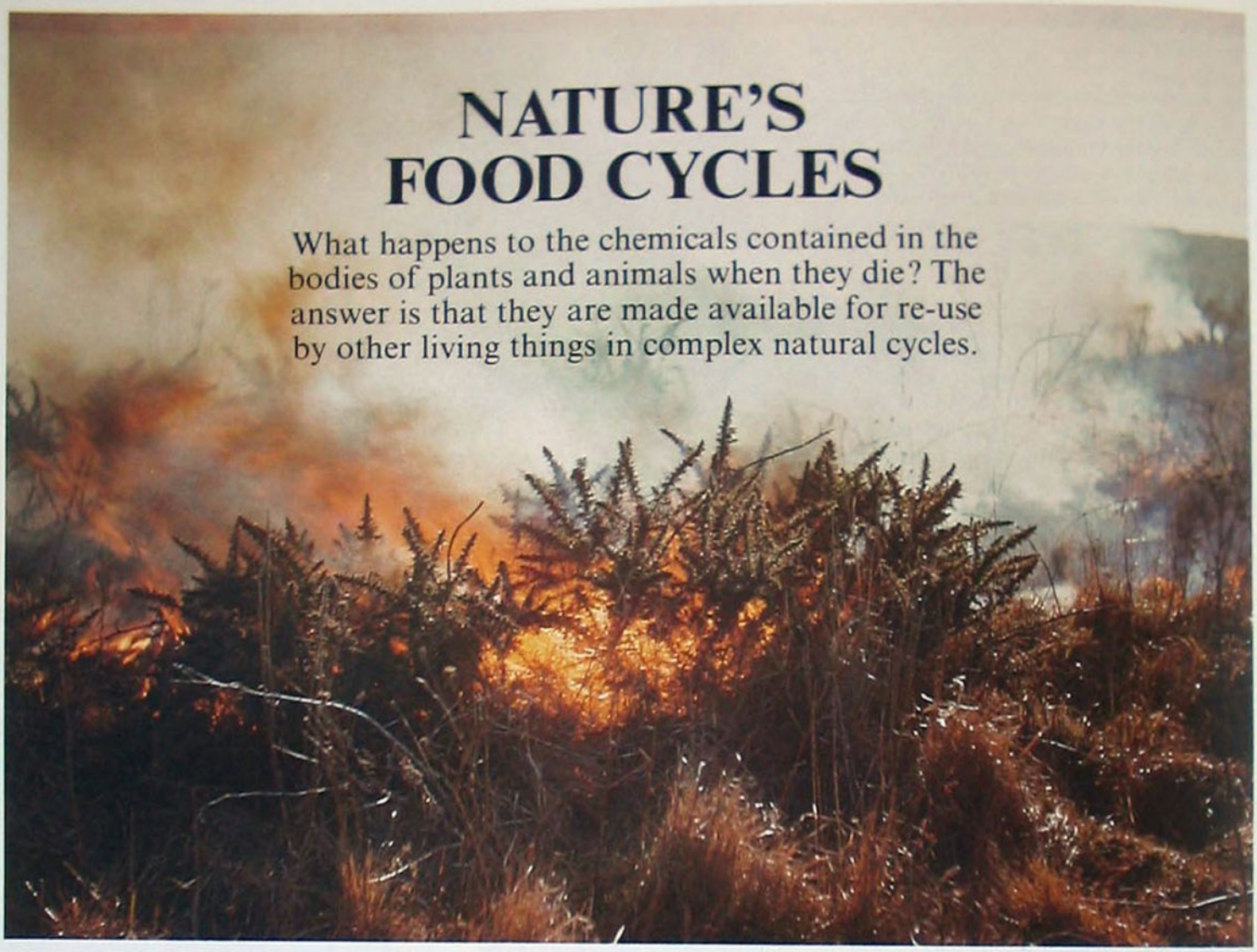
Above: **Sea kale** (*Crambe maritima*). Flowers May to August on high tide line. Ht 50cm (18in).

Above: **Sea campion** (*Silene maritima*). Flowers May to July on shingle and sea cliffs. Ht 20cm (8in).



NATURE'S FOOD CYCLES

What happens to the chemicals contained in the bodies of plants and animals when they die? The answer is that they are made available for re-use by other living things in complex natural cycles.



All living things–plants from the lowliest algae to the towering trees, and all the insects, birds, mammals and other animals–need certain chemicals if they are to build their bodies and have the energy for breathing, movement, growth and reproduction. These chemical elements in their bodies are not wasted when they die, but are broken down under the influence of various bacteria and fungi, eventually becoming available for re-use.

The steady build-up of chemicals in the body of an organism, and their re-use by other plants and animals, occurs in a series of natural cycles. Here we describe two–the carbon cycle and the nitrogen cycle. Carbon is essential for body building and cell respiration–the way plants and animals gain their energy; and nitrogen is used to form protein. Two more cycles–the phosphorus and the sulphur–are also looked at briefly.

The carbon cycle The source from which carbon is drawn is the carbon dioxide in the atmosphere around us. Animals are unable to use this gas to obtain carbon direct, but green plants can combine it with other chemicals to form sugars. This process, called photosynthesis, is the chemical reaction upon which all life ultimately depends for its supply of carbohydrates–the basic energy-producing compounds.

The sugars made by the green plants may be used as building materials to form fresh plant structures, or they may be used up in the chemistry of cell respiration. If sugars are used in respiration they are broken down and the carbon dioxide is once again released into the atmosphere.

Any sugars used to make plant structures may persist in the plant until it dies and is attacked by fungi and bacteria; or they may be taken into an animal's body when the plant is eaten by a herbivore–which thus

Above: Carbon is drawn by plants from the carbon dioxide in the atmosphere. Heathland fires like this one release carbon dioxide into the air as they burn, so replenishing the supply.

Below: Burying beetles help to break down the body of this dead hedgehog, so hastening the decomposing action of bacteria and the release of the body's carbon.

gets the carbohydrates it needs from the plant. The plant material eaten by these herbivores may again be used up in respiration or may be used to make cells and tissues for building up their bodies. Carnivorous animals get their carbohydrates by eating the bodies of herbivores.

Eventually all plants and animals die and the decomposition of their bodies by micro-organisms such as bacteria and fungi results in the carbon being released finally in the carbon dioxide of respiration. Some plants and animals do not decompose immediately after death, because of the acidic, bacteria-poor soil into which they fall, but are converted into peat, coal, oil or gas. These – the fossil fuels – represent a store of carbon locked away in the earth until man removes them. The burning of these fuels results, once again, in carbon returning to the atmosphere in the form of carbon dioxide.

The nitrogen cycle This cycle is more complex than the carbon cycle, involving numerous bacteria in a series of chemical stages.

The story starts in the atmosphere, 80% of which is nitrogen. There are very few organisms that can use nitrogen in the form of a gas; all the organisms that cannot are thus dependent upon the few algae and bacteria capable of converting nitrogen gas into a more solid nitrogen compound.

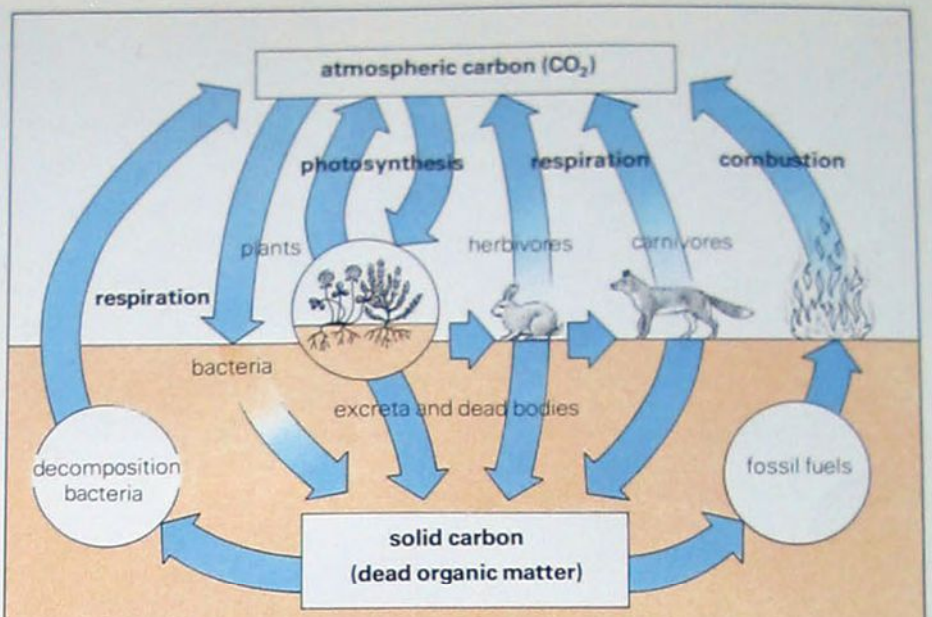
The conversion of nitrogen into a solid compound is called nitrogen fixation. The most important nitrogen fixers are certain bacteria, some living freely in the soil, others living within swellings or nodules on the roots of special plants (mainly leguminous species such as clover, vetch and gorse).

Whether free-living or in association with a legume, the nitrogen fixers convert the nitrogen into ammonium compounds. These compounds are in turn changed, first into nitrites and then into nitrates, by yet more soil bacteria. Nitrates are readily taken up by the roots of all plants and are used to make protein, which is the basic material for forming new cells and tissues.

The nitrogen found in plant tissue may remain unchanged until the plant dies or decays, or it may be eaten by herbivores. In this case it may be deposited in the waste materials of the animal, or may remain as part of the animal's structure until it also dies.

Whether in the form of dead plant, dead animal or simply waste excreta of an animal, the nitrogen ultimately finds its way back to the soil where it is attacked by decomposition bacteria. Such bacteria produce ammonium compounds from the dead material and thus return the nitrogen to the cycle, ready to be converted to nitrates again.

Coping with nitrogen deficiency The different bacterial actions described all need a non-acid soil containing oxygen. In acidic soil conditions, the decomposition bacteria cannot exist; therefore any dead organisms are



The **carbon** contained in dead organic matter and fossil fuels is cycled into the atmosphere: the first by the action of decomposition bacteria, which releases the carbon in the form of carbon dioxide by means of cell respiration, and the second when the fuels are burnt and give off carbon dioxide. Through photosynthesis plants obtain the carbon from the atmosphere and convert it into sugars. These are passed on to animals which eat the plants. Some carbon dioxide is returned to the atmosphere through respiration; the rest returns to the soil as dead organic matter for re-cycling.

Left: Plants combine carbon dioxide with other chemicals to form sugars, which may then be burnt up in the chemistry of cell respiration and be used to make fresh plant structures. Alternatively, the plant may be eaten by an animal – such as this grazing horse – and its sugars are then used in the animal's own respiration and body building.

Below: Lightning combines oxygen and nitrogen to make oxides of nitrogen which dissolve in rain to form weak acids. These acids react with rocks in the soil to make nitrites and nitrates – solid compounds that can easily be taken up by plant roots.

preserved from decomposition. This is seen in the preserved pollen grains of the acid peat bogs, or even in the preserved remains of man.

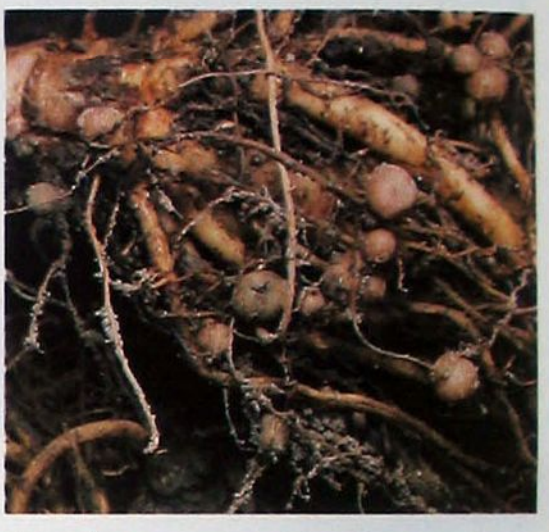
Heathland is a well-known habitat that lacks nitrogen. Part of this deficiency is due to the acidity of the soil. Some plants overcome the nitrate shortages of the acidic heaths and waterlogged areas by using animal protein. These carnivorous plants, such as sundew, butterwort and bladderwort, trap small animals like flies and actively digest them. The surfaces of their specialised leaves produce enzymes to break down the complex animal proteins into simpler soluble forms, which the leaves absorb.

Nitrogen loss There are three common causes of nitrogen loss from the soil. The first occurs in waterlogged soil which lacks oxygen; here there are special denitrifying bacteria that convert useful nitrates back to the gas, thus reversing the effects of the nitrogen fixation. This explains the necessity for agricultural land to be kept adequately drained.

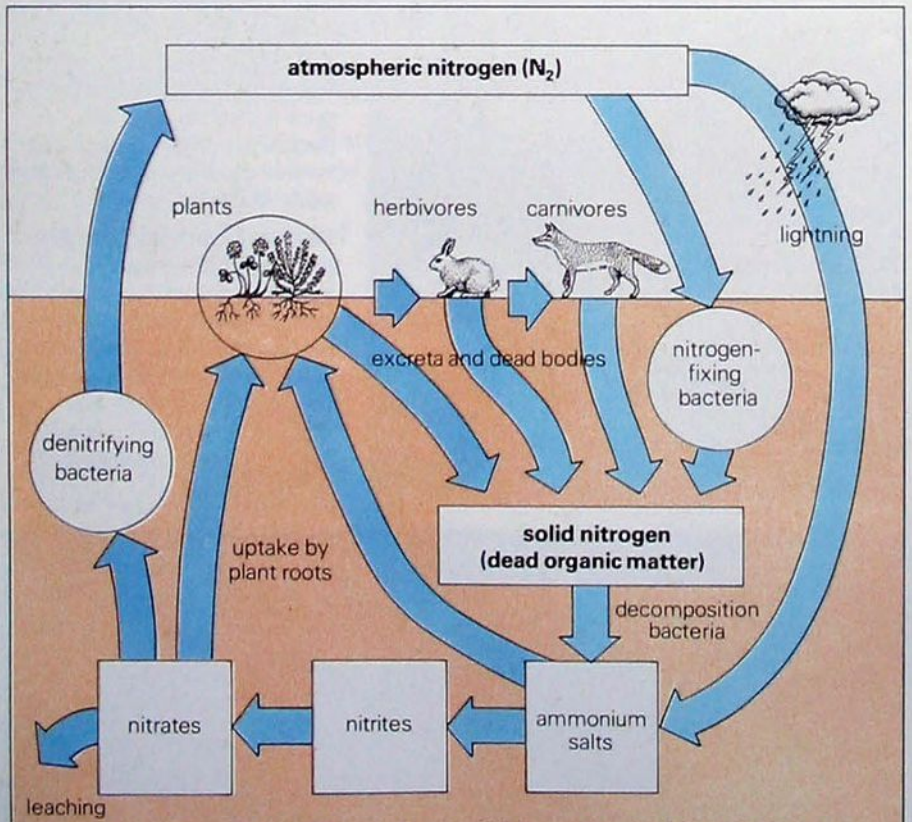
A second method of losing nitrates is a result of heavy rainfall. The nitrates are soluble and leach deep down into the soil, far removed from the regions colonized by roots.

The third way in which nitrates are lost is an exact opposite of rain – namely fire. When a forest fire rages, it consumes tons of plant material and converts the nitrogen of the plants into gases that are carried up into the atmosphere.

Above: The bladderwort is rootless and cannot obtain nitrogen in the usual way. Instead it traps micro-organisms in its underwater bladders and then absorbs the nitrogen directly from their living tissues.



Right: A few plants can 'fix' nitrogen and convert it into usable nitrates by means of special root nodules, which contain bacteria. The plants that possess these nodules are mainly leguminous species, like this runner bean.



Atmospheric **nitrogen** passes into the soil by the action of nitrogen-fixing bacteria; through the chemical reaction of lightning with oxygen; and by the action of bacteria on dead organic matter. Bacteria in the soil convert the solid nitrogen into ammonium salts, which are converted by other bacteria into nitrites then nitrates. The nitrates are taken up by plant roots and used to make protein. Animals eat the plants and so make protein for their own bodies. Nitrogen returns to the soil as excreta and dead bodies.

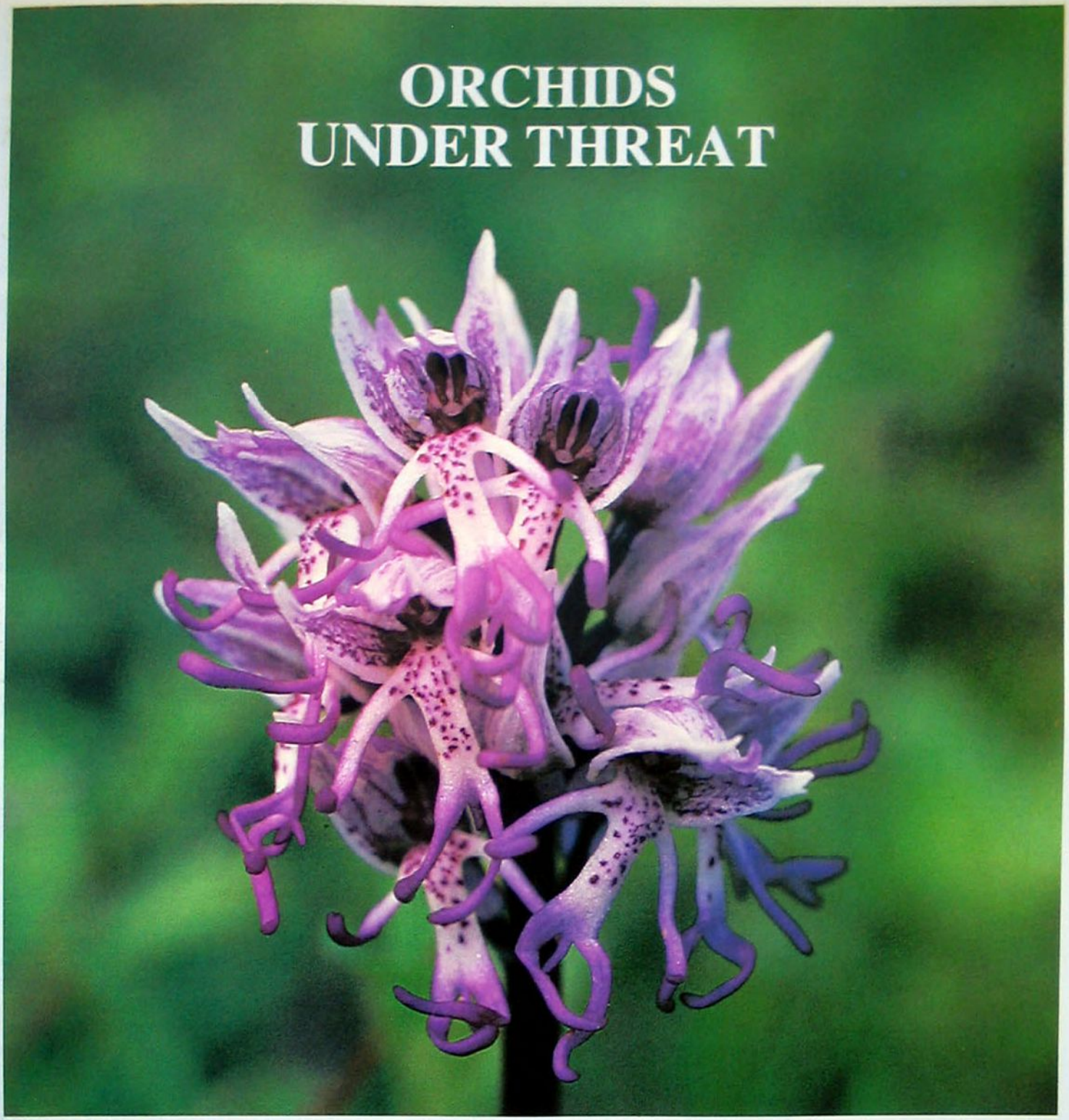
Under natural conditions, the cycle of nitrogen remains in balance, with the loss of nitrogen from the habitat due to fires, leaching, absorption by plants and denitrification being equalled by the addition due to fixation and decomposition. However, the influence of man can radically alter this, especially in any form of agriculture that removes vast quantities of plant material and returns an inadequate supply of nitrogen in the form of fertilisers.

Phosphorus and sulphur cycles All minerals used by plants and animals undergo some form of cycle. The movement of phosphorus and sulphur compounds are two such cycles.

Phosphorus is a component of all cells and is taken up into the organic world by the roots of plants in the form of phosphates. The plants may be eaten by a herbivore that finally dies, or the plant may die first. Again, micro-organisms decompose the plant or animal for further cycling of the essential chemicals. There is a problem in that many phosphates are washed away and deposited in the sea, where they combine with other chemicals to form rocks. There is a net loss from land to sea.

Sulphur is an essential constituent of plants and is taken up in the form of sulphates. When plants and animals die their sulphur is released by decomposition bacteria in the form of sulphides and sulphates.

ORCHIDS UNDER THREAT



Orchids have always been popular flowers, exhibiting an array of vivid colours, unusual shapes and fascinating lifestyles. However, this popular appeal is one reason for their rarity in Britain today.

Several of our orchids have become threatened species during the last 20 years as widespread agricultural changes have taken place. Such changes include the re-seeding of old meadows, the application of herbicides and fertilisers, and major drainage and afforestation schemes. Many habitats once rich in wildlife have disappeared as a direct result of these activities, and with them have gone some of our more sensitive orchids. Of the 49 species native to Britain today, almost one third are threatened and declining in numbers. Agricultural changes, together with plant collecting, are thought to be the major causes of this decline.

Over-collection Perhaps the greatest threat to orchids during the last century has been the plant collector. The decline of the lady's slipper orchid is a classic example of over-enthusiastic collection. Although never considered a common species, the lady's slipper

Above: The monkey orchid (*Orchis simia*) was once common on the chalklands around London. Disturbance in recent years from ploughing, house-building and collectors has been responsible for its sad and dramatic decline. It is in flower from late May to June, but the scarcity of suitable pollinating insects is thought to be noticeably influencing the numbers of flowers that are able to set seed.

Above: Limestone grassland, often near the coast, is the home of the early spider orchid (*Ophrys sphegodes*). It is now restricted to only 13 localities south of the Thames and it has suffered heavily from the trampling of holiday-makers, especially in the coastal districts.

Right: Irish lady's tresses (*Spiranthes romanzoffiana*) is a plant of the wetlands. Its white to cream-yellow flowers are arranged in three spirally curved rows, unlike the two other species of lady's tresses found in the British Isles, which only have a single row of flowers. Another species, the summer lady's tresses, a species of damp, acid soils, is already considered extinct in Britain; it was last seen in Hampshire in the late 1950s.

Below: The late spider orchid (*Ophrys fuciflora*) is affected in its downland habitat both by insufficient grazing and by the trampling of tourists' feet.

Unusual flower feature

The flowers of the bog orchid (*Malaxis paludosa*) reveal an unusual structure. The stem of each flower is twisted so that the lower lip points upwards. The purpose of this unusual feature is unknown.

was once recorded from over 20 localities in northern England. Today it is known to grow in only one site. Its virtual disappearance is due to avid collectors, the beauty of the plant perhaps being its own undoing. The one remaining site is well-guarded and conservationists are, as a last resort, attempting hand-pollination using a variety of techniques.

On the borderline Nearly all British orchids can be found growing in other parts of Europe, particularly in the Mediterranean area. However, in Britain many of the species are at the northern limit of their geographical range. As a result, the threats to their survival are often greater than for the same species growing elsewhere on the Continent, where ecological conditions may be more suitable. This explains why some of our orchids have always been rare and particularly sensitive to disturbance.

There are, however, a few species which seem to thrive under certain pressures. The man orchid, so named because the flowers are thought to resemble a human body, is one example. It appears to be particularly resistant to trampled ground and can be found in large numbers on the chalk downs around London.

Another feature of the orchid family is that many of the species are specialised, growing only in a particular type of soil or habitat. The early spider, man and lady orchids are confined almost solely to limestone grassland, while others, such as the ghost and bird's nest orchids, are to be found only in the dense shade of beech woods. These specialised species are particularly vulnerable to changes in land use and sometimes whole populations are eliminated if alternative sites for colonization cannot be found nearby.

Threatened wetlands Wetland areas are considered to be one of the most severely threatened habitats in this country. Many aquatic and water-loving plants have shown a marked decline in numbers, the Irish lady's tresses being one affected species. It is usually found in moist meadows and pastures where sedges, rushes and other bog plants grow, but its geographical distribution is most peculiar. It grows in south-west and north-east Ireland as well as Devon, Argyllshire and the Hebrides. Although the species occurs nowhere else in Europe, it is found as far afield as North America and parts of Asia.

Like so many of our aquatic plants, Irish lady's tresses is most severely threatened by drainage schemes. These are often necessary for farming purposes, but disturb the populations of this and other wetland orchids, including the bog orchid. Cattle grazing and trampling have also contributed to the decline of the species.

The bog orchid prefers an acid environment, growing among sphagnum moss in

Right: **Red helleborine** (*Cephalanthera rubra*). Flowers June-July in woodland. Ht to 50cm (20in).

Below: **Lady's slipper orchid** (*Cypripedium calceolus*). Flowers May-June on chalky soil. Ht to 45cm (18in).

bogs and fens on heaths and moorland. It has an efficient method of reproduction, the seeds dispersing by floating away on the water. It can also develop small buds at the tips of its leaves that are capable of growing into new plants. Although still common in Scotland, the bog orchid is threatened elsewhere by drainage schemes which dry out its habitat and prevent the spread of the plant.

Chalk and limestone grassland Most of our orchids prefer limestone soils and many are found on the chalk downlands of southern England and on outcrops in north-west England and Wales. The bee, common, spotted, man and fragrant orchids are among some of the more common species found on downland and they appear to be surviving the pressures on this rich habitat. The ploughing and re-seeding of downland and old meadows to improve animal pasture, and competition from artificially seeded grasses has, in many places, inhibited the growth of numerous meadow plants, including two of our now rare limestone orchids: the early and late spider orchids.

These two species are easily distinguished by the colour of their sepals and by their different flowering times. The early spider orchid, as its name implies, flowers early in the season from April to June, and its sepals remain green. The late spider orchid does not usually start to bloom until June and its sepals are a distinctive pink.

Woodland rarities The red helleborine, now the rarest of our helleborines, is confined to one or two beech woods in the Cotswold hills. The plant only flowers irregularly, hence picking the flowers in one year, from which it has suffered heavily in the past, may eliminate the species from an entire area for years to come. Its occurrence is closely linked to mycorrhizal activity and if a site becomes too shaded or overgrown, it becomes entirely dependent on its fungus partner for food.

Above: The light requirements of the bird's nest orchid (*Neottia nidus-avis*) are minimal and it can live in the deepest shade in beech woodland. Its brown colour merges well with its background and may have helped to protect it.

The bird's nest orchid, whose strange flowers can easily be mistaken for a dead plant, is a slightly more common woodland orchid. Its colour is due to a lack of chlorophyll, indicating a complete dependence upon the symbiotic relationship it has with an underground fungus. The species is named after its unique root system, which resembles a tangled bird's nest, with many thick roots growing from a short ground shoot.

Unusual coastal orchids The lizard orchid and dune helleborine are two of the few orchids in Britain to grow in coastal areas. The tall lizard orchid can be found in sand dunes and along woodland edges. The central lobe of each flower lip is dramatically elongated, giving each one a lizard-like appearance. Its populations are known to fluctuate and in the early 1900s it was thought to be extinct. This was followed by a period of rapid expansion in numbers, but after 1940 it declined again. Today, tourist pressure in coastal areas is reducing it even further.

The flowers of the rare dune helleborine are rather inconspicuous in comparison with the lizard orchid. Nevertheless, it has been unable to avoid human trampling in its coastal home. Since this plant is found nowhere outside the British Isles, the responsibility for its survival lies entirely in our hands. Fortunately, it is protected by law.

Flowers June-July. Ht to 40cm (16in).

Above: **Dune helleborine** (*Epipactis dunensis*).

SPONGES: PLANTS OR ANIMALS?

Don't make the mistake of thinking of sponges as plants, just because they remain attached to a particular rock or piece of seaweed. For sponges are primitive animals, feeding on particles filtered from water that they pump through their bodies.

To most people the word sponge conjures up images of the bath-sponge. But this (if not man-made) is the skeleton of just one particular species of sponge, among some 5000 species to be found throughout the world. Of these, about 230 species are native to Britain, most of which live in the sea.

Sponges are the most primitive of all multicellular animals, lacking body organs as well as a nervous system, and they have long fascinated and puzzled naturalists. The Classical Greek philosopher, Aristotle, believed them to be intermediate between plants and animals, but later naturalists were convinced that they were plants. It was not until 1825 that their animal nature was finally estab-

lished, when sponges observed through a microscope were seen to be pumping water through their bodies; the activity of pumping confirmed them as animals.

Sponge structure Sponges are classified into the phylum Porifera, a word meaning 'pore-bearers'. This is a reference to their body walls, which are covered by minute openings or pores that lead into channels extending into the body.

In the simplest sponges, the channels lead directly into a central cavity which is lined with special cells. Each of these has a flagellum that beats in unison with the others to create a current of water inside the cavity, so that fresh water is drawn in through the channels and discharged through a large opening in the top called the osculum.

This continuous flow of water provides the sponge with a supply of oxygen and food (such as bacteria, fine plankton and dissolved organic matter) and removes waste products.

Larger sponges have a more complicated structure in which the body wall becomes folded. This allows them to have more flagellated cells, creating a stronger current through the sponge and so making more food available. In the largest sponges the folding is taken to such an extreme that the central cavity has disappeared altogether. These sponges are capable of pumping as much as 22 litres (4.8 gallons) through their bodies in a day.

Spicules and spongin The body wall of a sponge consists of a gelatinous material strengthened with spicules, or with a horny material called spongin, though some species have a combination of both. The simplest group of sponges, with unfolded body walls, have spicules of calcium carbonate; this group is known as the Calcarea. The more complex Demospongiae (the largest group of sponges) include sponges with spicules of silica, often with spongin fibres, and others with a skeleton of spongin only. There are two other groups of sponges but these have no British representatives.

The spicules on a sponge are usually minute and invisible to the eye, but they can be felt if you rub a sponge between finger and thumb. Despite their invisibility, the spicules are an important guide to the identification and classification of sponge species–although sponges are among the simplest of animals they are extremely difficult to identify. This is partly because they lack distinctive organs and partly because the shape of their bodies may vary within a particular species according to the environment.

Where to find them Sponges fasten themselves to the sea-bed or along shores, encrusting rocks and vegetation. Those exposed to fast currents or large waves tend to be rounded or flattened against the substrate, which enables them to withstand the turbulence. In more sheltered sites, they are likely to resemble plants and have erect delicate branches.

Encrusting species may grow as a very thin film in exposed places, or they may become quite thick if sheltered.

Hermaphrodites Most sponges are hermaphrodite, containing both male and female sex cells. It is not known for certain, but fertilisation probably takes place in the water channels. One sponge releases sperm, which is swept into the water channels of a neighbouring sponge by the action of its flagellated cells. Here, the sperm meets an egg from the host sponge, fertilisation occurs and the egg develops into a small flagellated larva which escapes through the osculum. After a short spell as a free-living larva, it settles on the sea-bed, or on a rock on the shore, and develops into the adult form.

Sponges can also reproduce asexually, by producing small buds on their surfaces that break off and develop into a new individual. Although sponges can be pulled apart easily, they have remarkable powers of regeneration since each fragment is, under the right conditions, capable of growing into a new sponge. This ability is due largely to their simple structure and to the fact that sponges contain very few different types of cell.

British sponges A number of the calcareous sponges are found around the coasts of Britain. The simplest, with unfolded body walls, are members of the genus *Leucosolenia*, which can be seen in branching colonies attached to seaweeds, stones or rocks in sheltered parts of the lower shore. *L. complicata* is greyish-white with tubed colonies reaching about 2cm (1in) high; *L. botryoides* is similar but less branching.

Sponges of the *Sycon* group are also calcareous but have more complex, folding body walls. Their spicules often protrude well out

Above: A breadcrumb sponge, growing on a rock. This sponge can measure up to 20cm (8in) across and 2cm (1in) in thickness. Its surface is covered with oscula resembling small volcanoes.

Opposite: Purse sponges growing on red seaweed. Notice the single large osculum on some.

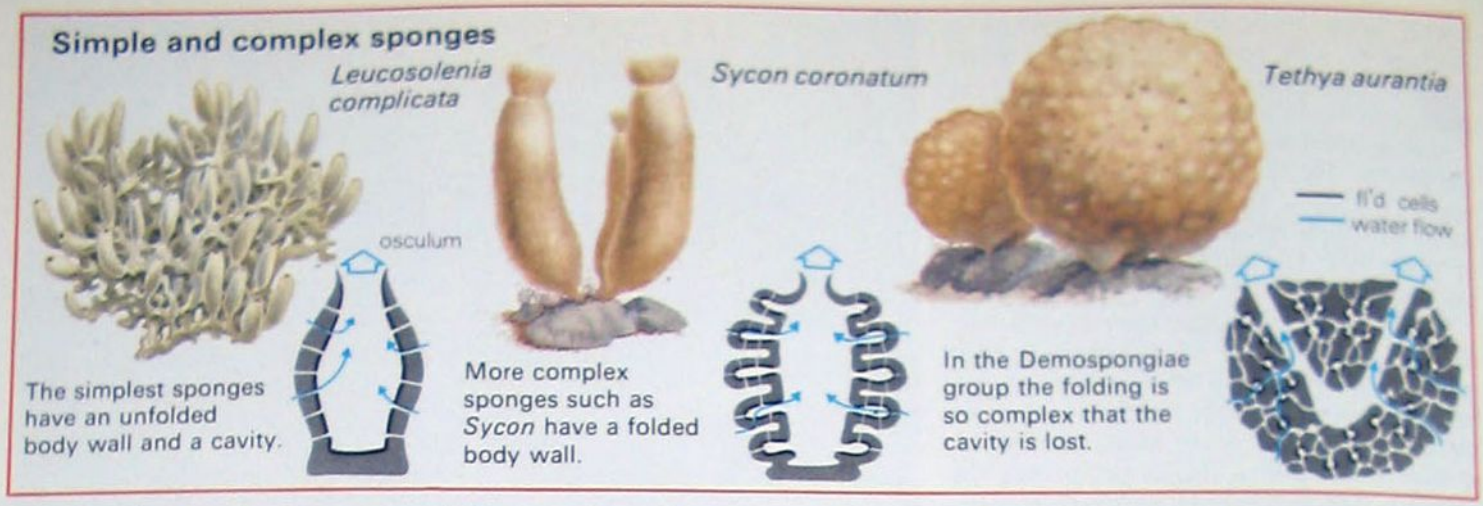
Bath sponges

The commercial bath sponge (*Spongia officinalis*) has been harvested for thousands of years–the Romans even used it for padding their helmets as well as for bathing.

The Mediterranean provides the best quality sponges and, for centuries, Greece was the main producer, but its sponge beds have long been over-exploited and now most Mediterranean sponges come from Tunisia.

Many sponges are still gathered by the old method of diving, but nowadays trawling and dredging are also used.

Commercially available sponges consist only of the skeleton; before it can be sold the sponge has to be treated to remove the living tissue.



beyond the body wall to form a jagged fringe. Two widely distributed species are *S. ciliatum* and *S. coronatum*. They are very similar in appearance, being about 3cm ($1\frac{1}{4}$in) high and creamy-yellow.

The other simple species common around our coast is the purse sponge (*Grantia compressa*). This sponge is white, grey or yellow and is often found in groups attached to the undersides of rocky overhangs, or to red seaweed on the lower shore and in shallow waters.

Colourful complex sponges Most of the simple sponges are drab in colour but the more complex species (members of the Demospongiae group) are often vividly coloured. For example, there is the blood-red sponge (*Hymeniacidon sanguinea*), which is a bright deep red or orange. It grows on rocks, forming encrustations up to 50cm (20in) across with numerous small oscula pitting its surface.

The breadcrumb sponge (*Halichondria panicea*) is one of the commonest of British sponges and is so named because of the way it crumbles when handled. It usually forms yellow or green encrustations on rocks and stones under water.

Living hotels Sponges are host to such a wide variety of animals that they have been described as living hotels. Worms, crabs and small fish are all likely to be found living in the water channels of a large sponge, and other animals live on the outer surface.

A few sponges have a more complicated relationship with animals. The boring sponge (*Cliona celata*) burrows into the shells of bivalves such as oysters and scallops. It probably does this by secreting an acid that dissolves the shell; it can cause serious damage in commercial oysterbeds.

The brightly coloured *Suberites domuncula*, commonly known as the sea-orange or the sulphur sponge after its pungent smell, has a symbiotic relationship with hermit crabs. It grows on whelk shells occupied by hermit crabs, giving camouflage and protection to the crab which, in turn, transports the sponge to new feeding sites. The sponge may eventually dissolve away the shell and provide the crab with shelter directly.

Above: The structure of different sponges with representative species, showing varying degrees of folding and the direction of the water flow.

Right: As well as growing on whelk shells occupied by hermit crabs, the sulphur sponge also encrusts rocks and stones.

Below: These small black dots are a colony of boring sponges growing on a shell of *Cyprina*. Each sponge is about 2mm wide.

BREEDING FOR SUCCESS

Birds have an intriguing variety of egg colours, laying times, clutch sizes and nest designs, arising from the endless search for ways to ensure survival of the young.

A long way back in time, perhaps over 140 million years ago, the fossil record shows that the first truly bird-like creatures developed as an offshoot of the reptiles. Unlike mammals, birds continue to use the reptiles' method of reproduction – the fertilised ovum developing inside an egg that is incubated outside the body of the adult until it is ready to hatch.

It is not easy to assess whether laying eggs is a better or worse method of reproduction than the mammalian system, in which the young develop inside the mother until birth. Each method has shown its advantages and disadvantages, and as the 'egg method' has endured for over 100 million years, it must be regarded as a success in evolutionary terms.

Eggs of all shades One striking feature of eggs is their intriguing range of colours and markings. Often it seems easy to attribute some advantage to the colouring – the black-speckled, sand-coloured eggs of terns or of the ringed plover, for example, are ideally camouflaged, for these birds nest on sand, among fragments of seaweed or on shingle beaches. The eggs of hole-nesting birds such as stock doves, woodpeckers and owls, are generally white: no doubt this helps the incubating bird to locate the eggs in the dark nest, and so avoid trampling on them. In addition, it seems natural that eggs so well

Above: An exceptionally large clutch of mallard eggs – the normal clutch has seven to eleven eggs. By laying larger clutches than other birds of their size, ducks compensate for the loss of young to such predators as pike and rats, or else to starvation in cold, wet conditions.

Below: A pair of reed warblers engaged in courtship feeding: this builds up the female's body reserves in preparation for breeding.

hidden need no colour camouflage. Birds that nest in crowded colonies need to recognise their own eggs, and this may be the explanation for the wide variety of ground shades (the basic colour of the egg) and black squiggles found on the eggs of guillemots in their cliff-ledge colonies.

There are, however, unexplained anomalies. For instance, each egg in every clutch laid by the red-backed shrike is a different colour: this has made them so attractive to egg collectors, from Victorian times to the present day, that the species has been plundered almost to extinction in England. Another anomaly is the dunnock: few birds are so well camouflaged as this species, its colours matching the undergrowth in which its nest is built. But once the sitting bird has flown what could be more glaringly conspicuous than the clutch of bright sky-blue eggs? Quite the opposite of being camouflaged, these must be positively eye-catching to predators such as jays and magpies.

Feeding for fitness For many birds, breeding success must depend heavily on the good physical condition of the pair. The whole breeding cycle must occur during a period when plenty of food is available. Well before the time for laying, the male needs plenty of food to give him the strength to perform his lively song and active display in order to attract a mate. He also needs all his strength to establish and hold a territory against rival claims.

The female must also get into first-class condition for the hardships of the breeding season. Courtship feeding, in which the male fetches caterpillars or other delicacies for his mate, has true practical importance: producing eggs requires a great deal of energy, and the female needs every scrap of food she can get. The female blue tit, for example, stores up so much food in her body that she increases in weight by half as much again during the fortnight before egg laying begins.

Nests of many kinds One advantage of laying eggs is that the mother does not have to carry heavy young within her body. But it gives rise to more problems in turn. First, eggs are fragile and need protection from breakage. Secondly, they need correctly controlled warmth and insulation from the harshness of the weather. Besides this, the eggs, and in most cases the young, are static and may be vulnerable to a number of specialist or opportunist nest predators. Birds have derived solutions to all these problems from a single feature – the nest.

The simplest 'nests' are merely places where one or more eggs are laid directly on to the ground. The eggs may be protected by their own camouflage or by the sheer inaccessibility of the nest site – a cliff ledge for example. In some waders and many ducks and gulls, the art of nest building is a little more elaborate: nearby vegetation is gathered into a heap to help insulate the eggs and offer some protection against change in the water level. The grebes have a subtle variation of this method: their nests are 'rafts' of vegetation that float on the water, rising and falling with the water level, and moored in place with pliable stems of long foliage.

The cup-shaped nest built by most small and medium-sized birds offers protection in a variety of ways. The eggs naturally cluster

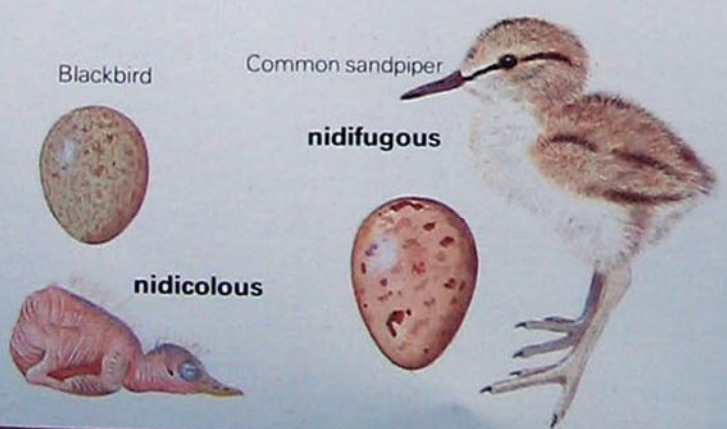
Left: Cuckoos practise a form of parasitism in their unique method of breeding. They do not build nests or look after their young, but lay their eggs into other birds' nests. The young cuckoo hatches first and ejects its potential 'brothers and sisters' from the nest. Here a dunnock is seen looking after a young cuckoo, thinking it is its own offspring. The commonest hosts are meadow pipits, dunnocks and reed warblers.

Opposite: Another unusual breeding method is practised by the short-eared owl: the owl lays its eggs at intervals of two days or more, and starts to incubate as soon as the first egg is laid. The eggs hatch at similar intervals, so that in a clutch of seven there may be a two-week difference in age between the oldest and the youngest chick. There is some flexibility in the size of the owl's brood, although it is achieved in a manner that we find distasteful: should the food supply diminish, the oldest may eat the youngest, and so on, until the family is reduced to a more viable size.

The helpless and the active young

Nidicolous (nest-loving) species of birds hatch naked, blind and helpless: these include most songbirds and some of the larger species, such as eagles.

Nidifugous (nest-fleeing) species hatch with eyes open and a covering of down, and can soon run and feed themselves; these include ducks, gulls and waders.



together in the base of the cup, where they are well insulated from cold and partly hidden from the eyes of predators.

Even better protection from prying eyes is given by domed nests, more complex structures made by small birds such as wrens and long-tailed tits. Tree holes also give good all-round protection, and are used as nesting sites by many species of birds, including owls, woodpeckers and pied flycatchers. Wheatears are well concealed in their nests in cavities among rocks and in walls, as are puffins in their underground burrows.

Timing it right In the course of evolution, a number of patterns of breeding have arisen that specifically take advantage of certain circumstances. The blue tit and great tit populations in Britain are a case in point. The majority of these birds depend on winter moth caterpillars as a supply of food for their young. These caterpillars occur in enormous numbers, but only for a month or so in early summer. To take the best advantage of this annual event, the blue tit or great tit lays its eggs all in one clutch, between 5 and 16 in number. Laying is timed precisely so that the young will hatch and grow to their most demanding size when the caterpillars are fully grown.

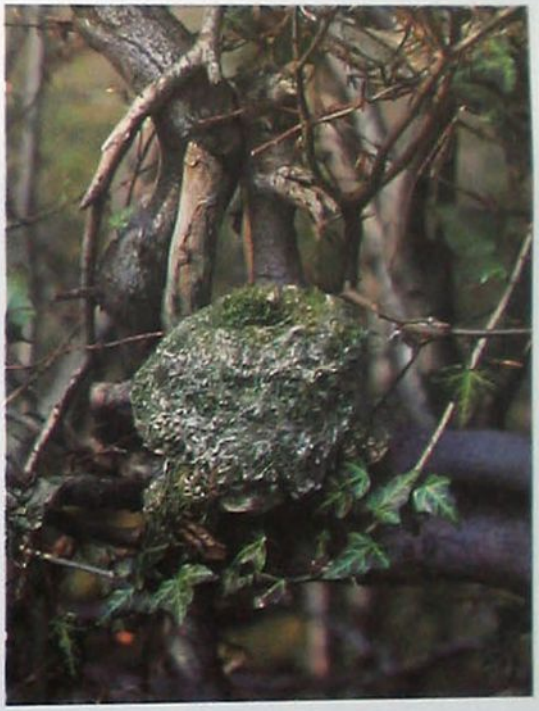
In contrast to this, almost a literal case of 'all eggs in one basket', the majority of small and medium-sized garden birds produce two or three clutches, and may even lay more in a good summer. Their clutches are smaller, with only four to six eggs. This method allows them to exploit a moderate food supply throughout the summer, rather than a short-lived glut in June.

The crossbill has a variable breeding time which, like that of the tits, is linked to the time of a particular food supply. This bird has a highly specialised feeding technique, for it lives on the seeds of pine and other cone-bearing trees. These may mature at almost any time of year, and the crossbill is able to adjust its breeding time to coincide with the supply, so it is possible to see crossbills sitting on eggs in winter.

The nesting brood The nestling stage is a time of considerable risk. The young are noisy and inexperienced, and may easily draw the attention of a predator. Parent birds have to spend almost all the daylight hours in ceaseless attempts to keep the young well-fed. In consequence the young are vulnerable to cold weather, heavy rain or hailstorms.

Birds clearly take great pains through spring and summer, and the young have to undergo many hazards before the lucky few that survive fly away and join the adult population. Many eggs and young are lost in the process, so the breeding patterns may seem highly wasteful; but their success can be judged by the variety and the numbers of birds that surround us in their many different habitats.

Above: A ringed plover's nest, superbly camouflaged on the shingle—so well that you may not notice it even when you know it's there! This nest is no more than a place where eggs are laid directly on to the ground, but in some of these 'scrapes' the ringed plover may make a scant lining with a few strands of seaweed or other plants.



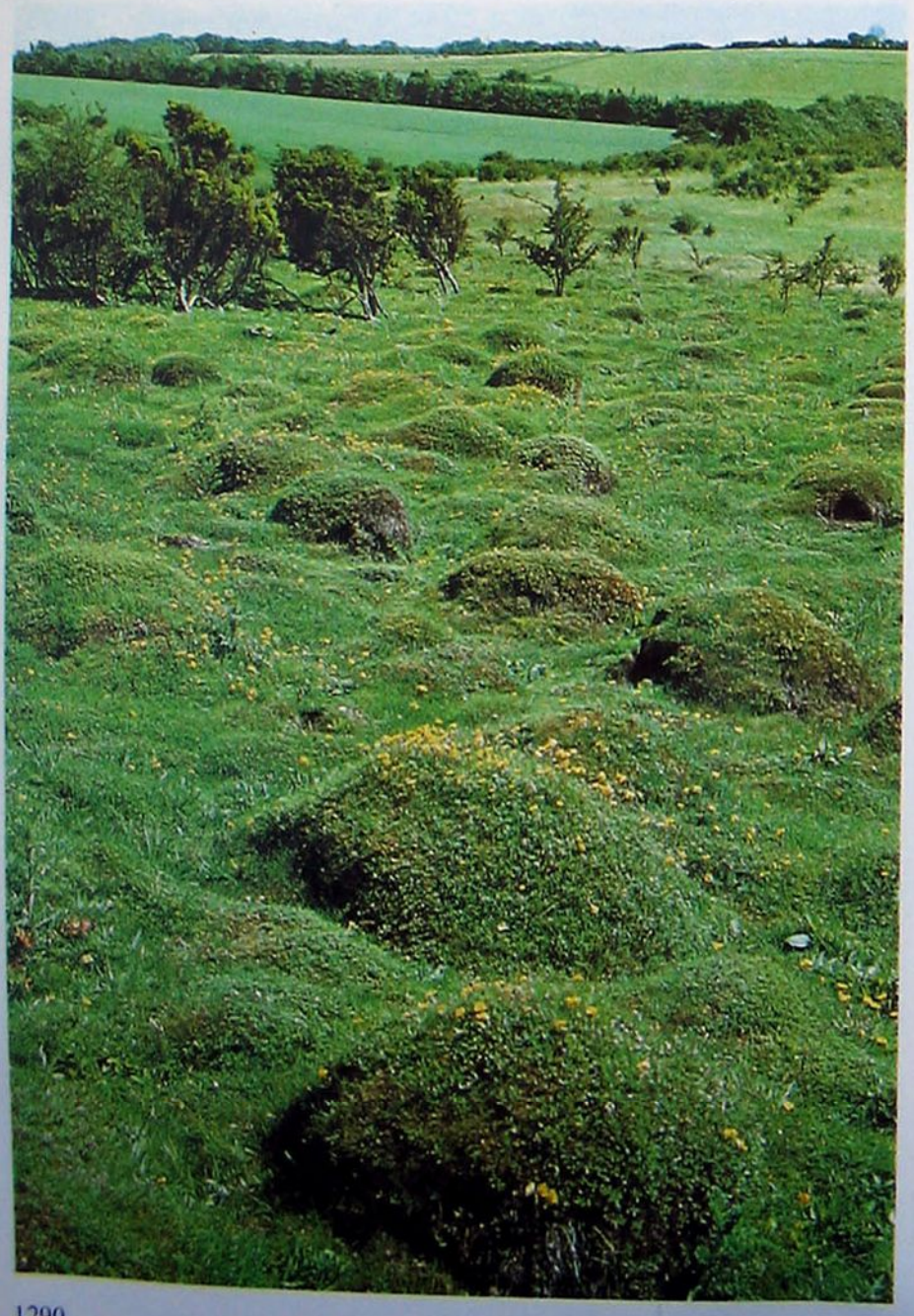
Right: The chaffinch conceals its eggs and brood within an elaborately constructed nest. The lichens that it uses to make the outer layers of the nest may also camouflage the nest if it is built on a branch that is also lichen-covered.

THE SECRET LIFE OF MEADOW ANTS

The mounds which appear all over fields and meadows house the nests of the yellow meadow ant and are often the only evidence of their presence. Rarely seen on the surface, these ants have an underground life which they share with a variety of creatures.

Below: Distinctive yellow meadow ant mounds. If the mound is soft and crumbly at the top then the ants are present and building; if it is hard, you can be reasonably sure the nest is deserted.

Some country people still speak of 'emmet casts', 'emmet' being the archaic English word for ant. 'Emmet casts' are the distinctive large mounds produced in uncultivated fields by the yellow ant. This species is also sometimes known as the yellow hill ant or the common yellow ant.



Meadow mounds The mounds of the yellow meadow ant are usually rounded or slightly elongated in shape. The old ones may be a metre or so in height and must be levelled if hay is to be cut or grown in a field. They usually have a long slope up to the highest point and then a steeper slope, which faces east or south-east. The ants live in, and continue building, the mound at the eastern end, possibly because of the combination of warm sun and morning dew that they find when they come to the surface.

Although their mounds are a nuisance in haymaking and other mechanical farming operations, ants improve the quality of pasture by aeration and by mixing the soil, which they bring to the surface from depths of a metre or more. In sandy soil or on steep slopes the yellow meadow ant does not make a mound at all. This is also true in gardens where cultivation, mowing and rolling of lawns prevents mound formation but does not destroy the subsurface nests.

Hierarchy in the nest In the meadow ant's nest the average population of workers is around 10,000, but may reach over 20,000; there is usually only one queen. The workers, which seldom see the light, have poorly developed compound eyes compared with those ant species that live and work in the daylight.

A queen ant mates only once, after which she may lay many thousands of eggs. If she fertilises an egg before it is laid, using one of the thousands of sperms stored in her body, it will produce a female–either a worker or

Above: The large queen yellow meadow ant sheds her wings almost at once after mating.

Left: Winged males and queens, shown here with the wingless workers, swarm from the nest during settled weather in late summer. They mate in the air, then the queens descend to the ground. Only a very few succeed in founding a nest or finding their way into an existing nest, and most perish.

Right: If a meadow ant nest is opened in summer, larvae and pupae can be found in quantity. The larvae are little white grubs whose size varies with age. The pupae are contained in oval cocoons, those of the males and queen being larger. The cocoons resemble very large eggs, and are as big as the ants themselves.

Below: Yellow meadow ant workers are very small, measuring only 2-5mm. They are sometimes confused with common red ant workers, which occasionally make their nests in a part of the mound of a yellow meadow ant colony. However, red ant workers are larger and darker, with a pair of backward-pointing spines on the hind part of the thorax. Examination of the pupae also helps to distinguish the species—yellow meadow ant pupae are contained in cocoons, while those of the red ant are naked.

Common red ant worker (*Myrmica ruginodis*).

Yellow meadow ant worker (*Lasius flavus*).

another queen. She can, however, withhold sperm altogether and the unfertilised egg will then develop into a male. This is the only way that males can be produced – a curious method of sex control that operates in all ants, wasps and bees.

Other nest-dwellers Many kinds of ants tend aphids in order to feed on their liquid excretions, which consist mainly of sugar and water derived from the plant sap on which the aphids exist.

The yellow meadow ants, which live almost entirely underground, compensate for their inability to tend aphids in the open by keeping special kinds of aphids in their own nest, pasturing them on the roots of plants that grow on the nest's surface. *Trama troglodytes*, a large, hairy aphid associated with plants of the daisy family, is found frequently in the nests of the yellow meadow ant, while *Forda formicaria*, a white or pale brown aphid, is virtually confined to ants' nests where it can be found singly or in little clusters on roots.

Another kind of insect attended by ants for the sake of their palatable secretions are the caterpillars of some of the blue butterflies. The yellow meadow ant tends the caterpillars of the chalk-hill blue butterfly, carrying them around, placing them on plants near their nests and even protecting them with soil.

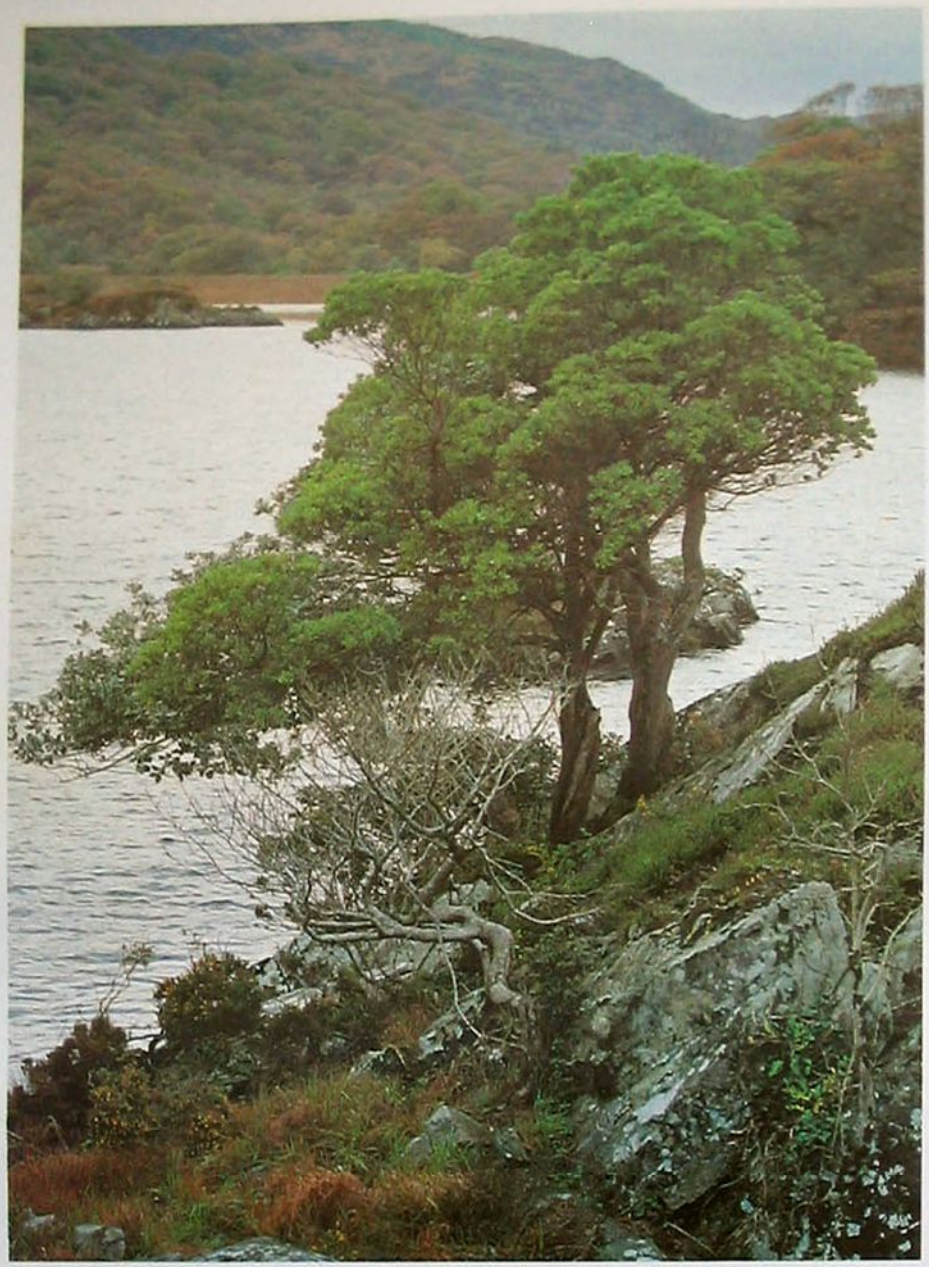
Ant guests Some small animals live in ants' nests, apparently as tolerated guests. One of these is the small white woodlouse (*Platyarthrus hoffmannseggi*), which is only found in the nests of a number of ant species, including the yellow meadow ant. It seems to feed on rejected pellets of indigestible matter and the ants take no notice of it at all.

Another guest with similar status and habits is the springtail. It is a tiny white insect, but conspicuous when a mound is opened up since it jumps actively about.

Finally, there is a curious relationship between yellow meadow ants and rabbits. The mounds attract rabbits, partly as vantage points and partly because they are comfortably warm to sit on as they catch the rays of the sun! The rabbits scatter pellets of dung on the mounds, enriching the grass and herbs growing there, to the advantage of the root-feeding aphids and of the ants which harbour them as an important source of food.

Underground 'farming'

The aphids kept underground by the yellow meadow ants seem to lead a secure existence, protected from the extremes of weather, and also from predators and parasites. Furthermore, the ants treat the aphids' eggs as they do their own, carrying them around and licking them to keep them free of moulds. Their lives are not, however, as carefree as this suggests. Besides milking them, the ants frequently kill and eat them to supplement their diet of various underground insects. The aphids' situation is thus very similar to that of cattle kept by man for both dairy produce and meat.



STRAWBERRY TREE: YEAR-LONG BEAUTY

Named after its fruits, which resemble strawberries in all but taste, the strawberry tree is one of those rare plants that remain decorative throughout the year, helped by its evergreen leaves and its distinctive reddish-brown bark.

Above: A strawberry tree growing beside one of the lakes of Killarney in south-west Ireland. Though native to both Britain and Ireland, the strawberry tree grows wild only in a few isolated parts of Eire, and only around Killarney is it at all common.

Of the 40 or so species of trees that are native to Britain and Ireland, the strawberry tree is one of the rarest in the wild. In Britain it no longer exists in its native state, though it is commonly planted in parks and gardens as an ornamental tree. Only in a few isolated areas in southern Ireland can the strawberry tree still be seen growing wild.

Evergreen tree or shrub The strawberry tree is a small evergreen tree, usually not more than 10m (33ft) high. It is more often seen as a large shrub since, typically, the stems branch from a central bole near the ground. A distinctive feature of the strawberry tree is its fibrous reddish-brown bark, which makes an attractive contrast to the dark green leaves. These have that hard leathery texture common to evergreen broad-leaved trees and are a dark shining green. They are borne alternately on the twigs and are elliptical with serrated margins.

In Britain and Ireland, the strawberry tree grows new foliage during the spring and summer, as would be expected in our climate, but in the Mediterranean region, where it is much more common, growth takes place during winter. At that time of year there is frequent rain but still plenty of sun, with temperatures often above 15 C (59 C), whereas the summers are hot and dry, and unfavourable to plant growth.

Urn-shaped flowers The strawberry tree is unusual in that its flowering period extends from October to December. The flowers are borne in drooping panicles and are variable in colour, being white, pinkish or even yellow on some specimens. Each flower is less than 1cm ($\frac{1}{2}$in) long and shaped like a pitcher – swollen in the middle and contracted at the mouth with small reflexed lobes. Their shape is sometimes said to be urceolate, which means urn-shaped.

A particularly fine variety of the strawberry tree (var. *rubra*) has flowers deeply flushed with red and borne in even greater abundance than on the wild tree. This variety seems to have originated in gardens.

Slow-ripening fruits As the flowers die away the previous year's fruits are finally reaching maturity. These are more or less spherical, about 2cm ($\frac{3}{4}$in) across and orange-red when ripe; when young they are yellow. Their surface is rough with small swellings, which helps them resemble strawberries. The fruits take nearly a full year to ripen and so, at one stage or other of maturity, are almost a permanent feature of the tree.

The fruits are edible, though they taste watery and insipid. The Ancient Romans found them equally unappetising, a fact referred to in the plant's Latin name, *Arbutus unedo*. The word 'unedo' is a contraction of 'unum edo', which is Latin for 'I eat one'; as the Roman naturalist Pliny explained in the first century AD, 'The fruit is held in no esteem, the reason for its name being that a person will eat only one.' In some European countries around the Mediterranean the fruits are made into a delicious liqueur.

The fruits are better fare for birds than they are for man and they are readily taken during the cold winter months. Sadly however, the climate in Britain is too cold for many of the flowers to ripen into fruits. One botanist has speculated that this may be due

to the lack of insects in the autumn and winter to pollinate the flowers. This seems a likely explanation – certainly, strawberry trees at Kew Gardens rarely show as much fruit as do those growing in milder south-western areas.

Scattered distribution The strawberry tree has an unusual distribution. Most grow around the Mediterranean – Spain, Portugal and Italy, and North Africa. In France it occurs on the south coast and near the south-west coast; then there is a considerable gap before it is found again in Brittany in north-west France. Further north, it is now found in the wild only in the west of Ireland.

Here, there is a small colony near Lough Gill in County Sligo, but the great majority are to be seen in the south-west corner of the country. Even there, the tree is becoming very rare. Two hundred years ago the strawberry tree was much more plentiful, but large-scale felling for charcoal to smelt local ores of silver, copper and lead has taken a heavy toll.

Today the best place to see wild strawberry trees is around the lakes of Killarney – the only area where they are still frequent.

Clifftop and woodland sites Around Killarney, strawberry trees can be seen growing in a variety of habitats, from clifftops to woodlands.

They are best developed on cliffs and open rocky slopes, where they grow mainly with ivy and holly, which are also evergreen. Here, many of the trees reach a considerable age and are often deeply gnarled and bent over, sometimes with only their twigs pointing upwards. Such trees often look dead, even though they are still living. One reason why these old strawberry trees survive so well is that they can send out shoots from near the bottom of the stem, where there is a prominent swelling. When the older branches die back or break, young shoots emerge from this swollen base.

The strawberry trees of Killarney can also be seen in oak woods where, with holly, they form a lower layer of the woodland canopy. Here they reach a height of 10m (33ft) or, occasionally, even 12m (40ft). However, as the oaks slowly grow the strawberry trees become shaded out. The presence of strawberry trees in these woods is, therefore, only short-lived; perhaps the wood had been cut down for charcoal, and strawberry trees were able to grow with the young oaks.

In Ireland the strawberry tree's only long-lasting habitat seems to be small cliffs and rocky shores where oaks cannot grow to any great height. That such a habitat is rare in Britain may, together with Ireland's milder climate, explain this tree's distribution.

Right: The strawberry tree has a flaking fibrous bark in which the dull reddish-brown outer layers peel away to reveal the more brightly coloured inner bark. Occasionally, strawberry trees have a single central stem but, more often, the stem divides above ground so that the plant resembles a large bush rather than a tree.

Above: The shiny dark green leaves of the strawberry tree are borne alternately on the twigs. Its white, urn-shaped flowers appear in panicles or singly in October and are followed by round pitted fruits that are yellow when young but ripen to a bright red.

Left: The fruits take almost a year to ripen, by which time the following season's flowers have emerged.

Strawberry tree (*Arbutus unedo*). Native evergreen tree, commonly planted for its ornamental qualities in parks and gardens, but no longer found growing wild in Britain.

TWO HIGH-FLYING BATS

Large, high-flying bats with narrow, pointed wings and fast dashing flight, noctule and Leisler's bats are remarkably similar in appearance.

Noctule and Leisler's bats are hard to tell apart but they are easily distinguished from other British bats. They are among our largest bats, with wingspans of over 30cm (12in). Their characteristically fast, dashing flight and their long narrow wings are particularly distinctive. Close inspection reveals that they have very broad muzzles and a heavy jowled appearance. Their ears are small and rounded with a tiny, almost semi-circular tragus within each ear.

Leisler's bat is distinguished from the noctule by its smaller size and its bicoloured fur – the base of each hair is darker than the tip.

Different distribution The noctule is common throughout England and Wales and absent from Scotland and Ireland, but the Leisler's is rare and patchily distributed. Little is known of the Leisler's ecology; therefore most of this article describes the more common noctule, assuming that the Leisler's habits are much the same.

Paradoxically, in Ireland the distributions are reversed. There, the Leisler's is common and widespread while the noctule is absent. It is surprising that noctules have not found their way to Ireland as they are strong fliers and, on the Continent, regularly undertake seasonal migrations of several hundred kilometres. There is also evidence which suggests that they fly across the English Channel from time to time.

A high flier Gilbert White, the famous 18th century Hampshire naturalist, was the first person to recognise the noctule as a separate species. He described it very clearly in 1789 and called it *Vespertilio altivolans*, a reference to the high flying behaviour so characteristic of this species.

Equally distinctive is this bat's habit of

NOCTULE (*Nyctalus noctula*).
Size Wingspan 30-40cm (12-15in); forearm length 47-55mm (1¾-2in); weight 15-40g (½-1½oz).
Colour Upperparts bronze, underparts slightly paler. Unlike the Leisler's bat, the noctule's hairs are the same colour throughout their length.
Distribution Common throughout England and Wales. Absent from Scotland and Ireland.

LEISLER'S BAT (*Nyctalus leisleri*).
Size Wingspan 28-34cm (11-13in); forearm length 39-47mm (1½-1¾in); weight 11-20g (¼-¾oz).
Colour Upperparts golden brown, individual hairs have dark bases. Underparts lighter, slightly grey.
Distribution Rare in England and Ireland. Absent from Scotland and Wales.

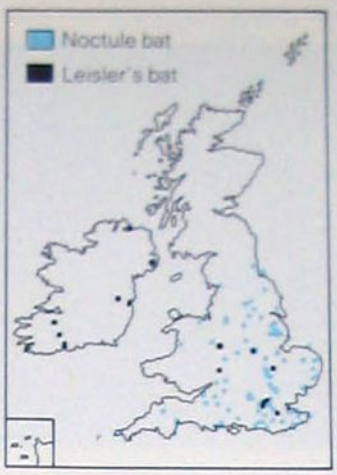
leaving its roost in early evening and zooming about the sky long before it is fully dark. On warm summer evenings it is common to see noctules searching for insects in the company of swifts that have not yet gone to roost. In the fading light they can easily be watched through binoculars as they chase insects, flying straight and high up to 150m (500ft) above the trees.

The noctule has long narrow wings which enable it to fly fast, but its large wingspan also makes it difficult for the bat to manoeuvre well among tree branches and foliage. Consequently it is very much a bat of the open skies, catching and eating its prey on the wing, and only occasionally diving down to catch a moth, beetle or other large insect flying near the ground. In some places noctules regularly swoop low over rubbish tips to seize crickets and, during a brief period in the summer, they repeatedly dive to seize cockchafer beetles, a large, nourishing prey. Most British bats do not tackle such substantial food items. Although most of the noctule's food consists of flying insects, careful study of prey remains in their droppings suggests that they also pounce on creatures such as spiders from the ground, or whisk them from walls or tree branches.

Tree-dweller The noctule is essentially a tree-dwelling bat, although it sometimes inhabits house roofs. Rotten hollow trees provide an ideal home and woodpecker nest-holes are another favourite place – from which they may sometimes be evicted by starlings wanting somewhere to nest. A dozen or more noctules may crowd into such a roost; in larger spaces up to 100 of them can be found roosting together.

Colonies 'move house' several times during the summer, using a succession of roosts. They may do this to avoid overheating – on a hot summer's day an overcrowded hollow tree may become too warm, causing the bats to seek another home in a cooler spot.

Breeding During summer males and females often live in separate colonies, the females forming nursery roosts. Here the young are born in June or July after a gestation period of about two months.



Opposite: The noctule is much larger than the Leisler's bat. Its short fur is a lustrous bronze colour. Both bats have short rounded ears with a small, almost semicircular tragus within. The face, ears and wing membranes are, by contrast, dark brown.

Below: Leisler's bat looks very like the noctule. It often roosts in large, mature trees. It has several times been found in heavily built-up areas, roosting in big, hollow elms in parks and gardens.

As in other bats, the noctule's baby is enormous at birth – over one quarter of the weight of its mother. This must be a considerable burden for the mother in flight during the late stages of pregnancy. Even after the baby is born the mother will, under exceptional circumstances, carry the youngster to another roost, with it clinging to the fur of her belly. However, it is unlikely that she could manage this feat over more than a few hundred metres. Like most bats, noctules normally have only one young per year, but they sometimes produce twins – the only British bats to do so.

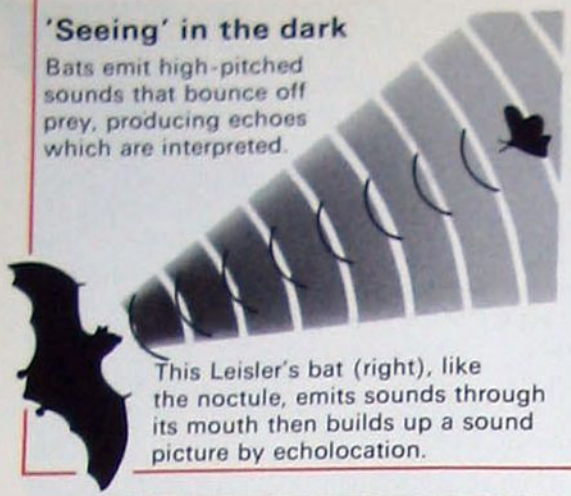
Bats normally hang head downwards in the roost, but during birth a female bat crawls round to face upwards. Then, as the baby is born, it can drop down and be held by the mother's tail membrane where she can lick it clean. The mother forms a strong attachment to her young, recognising it in the darkness of the roost by its voice and smell. Thus the female can leave her baby, go out and feed, then return and feed her own offspring. This pattern continues for six to eight weeks, until the baby is able to fly and forage for itself.

The first flight is critical – there is no room inside a hollow tree for practising, and barely enough, indeed, even to exercise the wing muscles. So when the time comes, the youngster has no choice but to launch out, fly around and return – all on its own. If it falls to the ground there is little chance of its being able to take off again or crawl back to the roost and, as its mother cannot help it on the ground, it is a case of 'fly or perish'.

Hibernating During the coldest months noctules hibernate. They can tolerate low temperatures, even below freezing, so, unlike

'Seeing' in the dark

Bats emit high-pitched sounds that bounce off prey, producing echoes which are interpreted.



This Leisler's bat (right), like the noctule, emits sounds through its mouth then builds up a sound picture by echolocation.

Left: Like the noctule, the Leisler's bat is strongly associated with large, mature trees in which it roosts during the daytime and hibernates during winter. Adult females separate from the males and form large nursery roosts during the breeding season.

many bats, they do not need to seek the warmth of caves and mines, but pass the winter in more exposed places such as hollow trees.

Hibernating groups often comprise both sexes in equal numbers, and mating can occur in autumn or in brief periods of activity during winter. Individual males may mate several times with the same female.

It is important that the young are not born too early the following year as there will be insufficient insect food available for them and their parents before about June. To overcome this problem the sperm is stored inside the female, nourished by special secretions, until the egg is ready for fertilisation in early spring. Sperm can be stored unharmed for up to seven months in this way–over a hundred times longer than is possible in other mammals.

Senses of smell and hearing We are only just beginning to understand the details of the biology of scent in mammals, and nothing is known about how it works in bats–despite its obvious value for animals that live in the dark and despite the large size of scent glands among bats, noctules in particular. The noctule has large glands on its face; these exude a white, greasy, scented secretion strong enough even for humans to detect.

It is likely that smell plays an important part in mating, when it is obviously necessary to establish the sex of the other bats in the roost. It is vital for females to recognise their own babies, and it may also be useful in helping bats to find their roosts, or to recognise a place where other bats are living. For the noctule this last factor may be especially significant as this species is so active in summer. An individual may move from one colony to another and back again, forming and reforming social attachments several times in just a few weeks.

Like such bats as the horsehoe, both the noctule and the Leisler's bat emit high-pitched sounds when hunting. These bounce off objects, such as prey, returning echoes that the bats can then interpret. But unlike the horseshoe, these bats make sounds through their mouths, not their nostrils. In some cases the squeaks are not as high-pitched as those of the horseshoe, and can even be heard faintly by the human ear. Although these bats may have poor eyesight, they can build up a sound picture of their surroundings which enables them to avoid obstacles and locate prey.

Below: This noctule bat is walking on the ground–a fairly unusual sight as this is very much a bat of the open skies where it catches large, flying insects. By eating large insects it avoids competing for food with smaller bat species.

A SPRING WALK IN WARBURG RESERVE

A few miles north of the busy riverside town of Henley-on-Thames is the Warburg Reserve, one of the finest nature reserves in the Home Counties. It is an area extremely rich in birds, butterflies and wild flowers, including 17 species of orchid.

Below: Mixed woodland in the Warburg Reserve. The wild flowers in the foreground, and the variety of shrubs and trees, represent just some of the wealth of species to be seen on a walk round this Reserve.

Situated in the steep-sided, wooded coombe called Bix Bottom, Warburg Reserve – an area some 105 hectares (260 acres) in extent – was bought in 1968 by the Berkshire, Buckinghamshire and Oxfordshire Naturalists' Trust (BBONT); it was named in honour of the Trust's first Oxfordshire Vice-President, the famous Oxford botanist Dr E F Warburg, co-author of the standard book on British flora.

The Reserve consists mainly of woodland, with a few patches of chalk grassland. Most of the woods have been felled at some time during this century, so that there are a great many young trees and several acres of planted conifers. However, there is also an exceptionally wide variety of wild flowers, birds and butterflies.

Valley of the birds The best place to start a walk round the Warburg Reserve is at the car park, close to the Trust's Information Centre. From here a few steps bring you to a broad open glade, once a Territorial Army Range. The tall dark conifer on your right is a Douglas fir. Quite a number of these firs are scattered about the hillsides; they are relics of an earlier phase of afforestation. Crossing the Rifle Range, the path runs along the edge of a patch of coppiced beechwood, a reminder of the days when the High Wycombe furniture trade used local timber and many Chiltern

beechwoods were coppiced to provide arms and legs for chairs and tables. (In coppicing, a tree is cut back every ten or fifteen years, whenever the branches or stems have reached the required size. Hazel, used for hurdles, was the tree most often coppiced in this manner.)

In spring this whole valley resounds with bird song. Not only the commoner species– blackbird, song thrush, robin, hedge sparrow and wren–but also all the regular woodland species of southern England occur. Among them are the blackcap, garden warbler, chiffchaff, willow warbler and both the marsh and the willow tit.

Jays, so noisy at other times of the year, are rather silent in spring, and so is the sparrowhawk which may glide overhead. You may hear both the green and the great spotted woodpeckers calling, the green with its loud ringing 'yaffle' cry and the great spotted with the curious drumming noise it makes by hammering on a dead bough. And if you can be there at dusk, you may well see a woodcock, whose owl-like 'roding' territorial flight is accompanied by two curious notes– a rather sibilant 'twisick' and a frog-like croak or grunting growl.

Two plants to look out for in spring on the Warburg Reserve are the wayfaring tree (above) and the delicate columbine (left); both flower from May to June. The berries of the wayfaring tree, red in this picture, turn black as they mature; they are edible but taste unpleasant. The columbine, for all its beauty, is poisonous. It is also worth keeping an eye open for adders (below). They like to bask on the banks near the Rifle Range. They are harmless if left alone.

Flowers of the chalk Soon the path emerges into another broad glade, where many of the wild flowers of the chalk grow. On the left are the remains of a plantation of Corsican pine, now fast turning into a birchwood as the pines are felled; and on the right is an old larch plantation, fringed by some special shrubs of the chalk, notably wayfaring tree (a shrub, not a tree) and dogwood. The white flowers of the wayfaring tree will have finished blooming by May, but the berries it bears, red at first, then black as they reach maturity, may have started to appear.

The chalk flora is represented by yellow rockrose and birdsfoot-trefoil, hairy violet, blue milkwort, and the glaucous sedge or carnation-grass with its tufts of pale yellow stamens. Later in the season you can see blue harebells, purple marjoram and wild basil, and the tall, flat-headed spires of ploughman's spikenard, whose rosettes of basal leaves look like foxgloves.

In the woods, too, there are many special plants: mezereon, which may bloom in a mild January; herb Paris, hard to find among the green sheets of dog's mercury; blue columbine (also called aquilegia and granny's bonnet), and the poisonous green hellebore, another early flowerer, which can most easily be seen in the hedge of the lane bordering the car park. The green hellebore belongs to the buttercup family and has apple-green flowers which are the same colour as its leaves (don't

Above: The Warburg Reserve has an amazing 36 different species of butterfly. They are attracted by the mass of wild flowers that provide a plentiful supply of nectar. This speckled wood is one species you might see in spring. The adults can be on the wing as early as March and as late as October. The green caterpillars feed on various grasses, including couch grass and cock's foot.

confuse it with the helleborines, which are orchids flowering in summer.)

Beautiful butterflies Where there are flowers you will also find many of the 36 butterfly species of the Reserve. In spring the bright yellow brimstone is likely to catch your eye. Any white butterfly you see is more likely to be either a female brimstone or a green-veined white than a cabbage white.

Later in the year you should see both the black-and-white chequered marbled white and the speckled wood, whose pale-spotted wings camouflage it in the sunlit clearings.

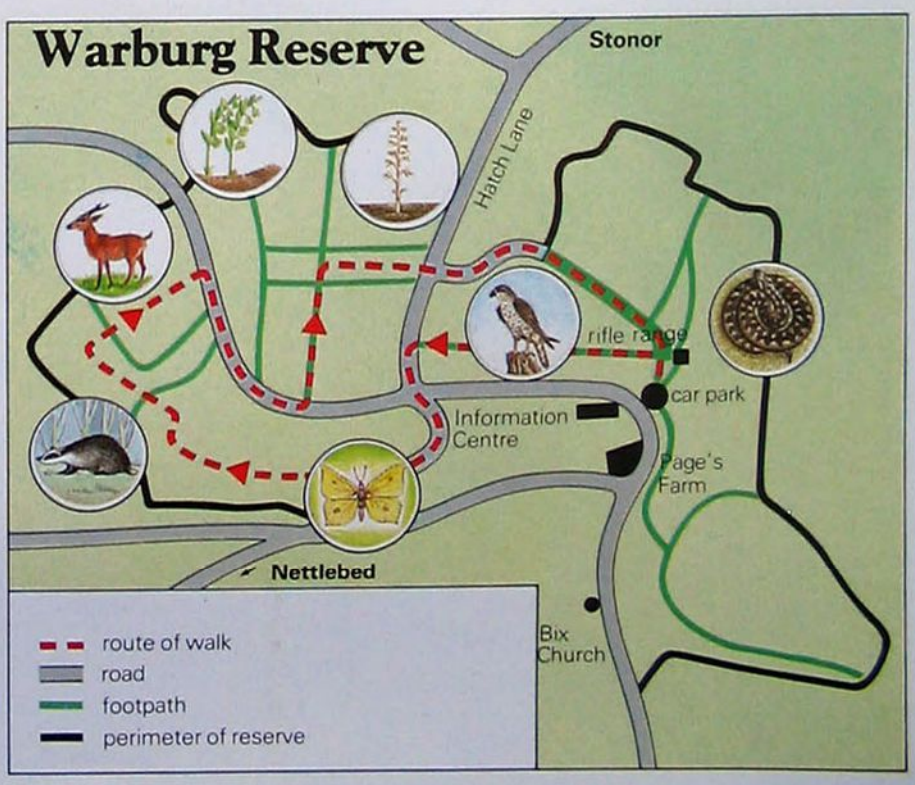
Warburg mammals The track continues through a wooded area and across a bridleway into another broad open glade. At the crossing you pass between two plants of spurge laurel – an attractive small shrub with laurel-like leaves, yellow-green flowers and black berries. Like mezereon, it is a relative of the numerous daphnes to be found in gardens.

In the middle of the glade, turn sharp left and go downhill. Hereabouts is the home territory of a pair of badgers which have made numerous holes in the soft, sandy soil. Deer, too, are as likely to be seen here as anywhere in the Reserve, especially early or late in the day when they emerge from their hideouts in deep woodland to forage. Fallow deer which have escaped from nearby Stonor Park can be seen, and muntjac or barking deer (a dog-sized Chinese species), which escaped from Woburn Park in Bedfordshire many years ago and are now widespread in the Chilterns.

Orchids across the valley At the bottom of the hill turn right up the main track, past a patch of wild Solomon's seal, on up the bank and past a substantial holly tree, and carry on to a glade that, in late spring, is brilliant with the yellow-green flowers of wood spurge. Turn left again here and ascend the other side of the valley, until you reach a beechwood on the crest. The delicate green of the young beech leaves is at its best and most beautiful in May.

The path, continuing along the side of the hill past a number of fine yew trees, gives splendid views northwards to Maidengrove village. Before long it reaches another main track going back to the left. Here, quite close to the path, you may find both the greater and the lesser butterfly orchids with their sweet-scented, creamy white flowers, and also the odd-looking honey-brown birds-nest orchid. This last is a saprophyte and feeds on rotting vegetation, nearly always growing in

Below: If you follow the route suggested here you should gain an excellent idea of what the Reserve has to offer.



deep shade.

Back to the rifle range More orchids may be seen when you descend to the main track past some overgrown old coppiced hazels. Cross this track and turn right again back on to the Rifle Range. Here you are likely to find spotted orchids, and bee orchids as well. The lower lip of the bee orchid looks like the rear end of a small bumblebee – a resemblance that makes it an easy orchid to identify. In the woods as you walk round the reserve, both early purple and fly orchids grow, and so, on the grassland in June, do both the pyramidal and the fragrant orchids. Both these latter two species are purple-pink in colour.

Returning down the rifle range towards the car park, keep an eye open, if it is a hot and sunny day, for adders basking on the bank to the left of the track. This is one of their favourite sunbathing places and they are quite harmless if not disturbed. Also look upwards for the chance to see a hovering kestrel, at the same time keeping your ears alert for the soft pipe of a bullfinch coming from the vegetation bordering the path.

Getting there Take the Henley-Watlington road (B480), turning left at Middle Assendon, three miles north of Henley, on to a lane that goes for two miles into the hills and passes the old ruined church of Bix on the left. London-Henley-Oxford buses stop at Nettlebed, from where it is a walk of about three-quarters of a mile to the Information Room on the Reserve.

There is no admission charge to Warburg Reserve, although it is hoped that visitors will contribute to the cost of its upkeep (there is a collection box in the car park), all of which is defrayed entirely by voluntary contributions. Any money you contribute helps to maintain the Reserve and all its wildlife.

Above: The wooded valley of Bix Bottom is alive with a host of birds, and in spring resounds with their songs and calls. One bird, however, usually noisy at other times of the year, is silent in spring; this is the colourful jay. But even if you don't hear its raucous voice, you may see it winging its way through the woods, its blue and black covert feathers flashing. You might even find one of these feathers on the ground. Jays nest low down in thick undergrowth, building a robust, well-concealed structure for their eggs.
Other birds of the Reserve are the sparrowhawk, the green and great spotted woodpeckers, the blackcap, chiffchaff and woodcock.

Above: More than for any of its other plants and animals perhaps, the Warburg Reserve is famous for its marvellous display of orchids. There are 17 different species, among them the lovely, creamy white greater butterfly orchid shown here. This species flowers from May to July and reaches a height of about 40cm (16in); its flowers are sweetly scented.

Left: The fallow deer that roam the sunlit woodland glades of the Reserve are escapees from nearby Stonor Park. The deer in this picture are both does – one is grazing while the other is grooming itself.

LOOKING THROUGH MAMMALS' EYES

Sight is an intriguing sense in mammals. It is essential for detecting movements of prey or predators at a distance, and helps animals to find food, mates and shelter. It is also an extremely good way of learning about the surrounding habitat.

A badger at night. Sight, the least effective of the badger's main senses, is used to gain a general impression of other movements in the habitat, rather than for detailed vision. The badger's white, glassy stare comes from its special adaptation to nocturnal living. In all mammals the retina contains light sensitive cells, but the retina of nocturnal animals also has special reflective material that maximises what little light is available.

Although all mammal senses are a brilliant achievement of evolution, perhaps sight seems the most miraculous to most people. The eyes of different species are very varied in size and shape, but they all have the same basic structure, with modifications to suit the needs of the particular species.

Structure The eye is a roughly spherical organ controlled by a number of muscles that allow it to swivel in a protective bony orbit. Its cornea is a sensitive transparent layer bathed with fluid from the tear ducts which helps to wash away dust and provide it with nourishment. The iris, a pigmented layer of thin sheets of muscle, regulates the size of the pupil – the gap through which light passes into the eye. The lens separates the two large chambers of the eye: the cavity in front of the lens filled with a runny liquid (the aqueous humour), and the cavity behind the lens filled with a stiffer jelly (the vitreous humour).

The retina, containing the light-sensitive cells and covered by a thin layer of nerve cells, lies at the back of the large cavity. The nerve cells leave the eye at the blind spot and carry the impulses to the brain. (The blind spot is so-called because any image that falls on that region of the eye is not recorded in the brain. In some mammals, such as the squirrel, the 'spot' is quite a large area in the eye.)

How the eye works Light enters the eye and, although it is deflected by the fluid contained in the cells of the cornea, proper focusing is carried out by the lens, which changes shape to focus the light on the retina (see diagram on page 1303).

Since light must always focus on the retina to produce a sharp image, the lens becomes thin when the eye focuses on distant objects and more spherical when focusing on near objects.

The lens is controlled by muscles in the ciliary body pulling on the suspensory ligaments, thus altering the shape of the naturally elastic lens. As mammals age, the elasticity of the lens is reduced, so it is increasingly difficult to focus on near objects – the problem of long sight is well known in middle-aged man. Light falling on the retina stimulates

The eyes of herbivores, such as rabbits, are well back to the side of the head giving a huge area of monocular vision and even a slight overlap at front and back. Carnivores, like foxes, have forward-facing eyes with vertical slit-like pupils that give precise, overlapping vision more suited to hunting prey.

the overlaying nerve cells which carry the impulses, via the optic nerve, to the brain where they are interpreted as images. The pupil size also varies in reaction to the amount of light entering the eye.

Types of vision The retina in mammals is a complex structure composed of several layers of cells. The actual light-sensitive cells are of two types: rods–long, thin cells, sensitive to changes in light at low intensity but incapable of detecting colours; and cones –shorter cells sensitive to high light intensity that may detect different colours. Some mammals, such as bats, have a retina that contains only rods, so they are clearly incapable of detecting colour. In nocturnal mammals the amount of light available would anyway be inadequate to stimulate the cones. Colour vision is rare and little understood in mammals, and of British mammals man undoubtedly has the best perception of colour; most mammals see in black and white and shades of grey. Cones also give the eye acuity–the ability to see clearly: the greater the number of cones, the greater the detail seen.

The fovea, or yellow spot, is the region in the retina with the greatest density of cones. Man has approximately 30,000 cones in his fovea. A squirrel, too, has a cone-rich fovea resulting in the precise vision that enables it to jump from branch to branch or hold a hazelnut accordingly in its claws, and to see in colour.

Seeing in depth Man, and some other mammals, can see in three dimensions, in other words in depth. Both eyes used simultaneously receive two slightly different views of an object which the brain merges into one single three-dimensional image. This is known as stereoscopic vision. It is found in hunting animals such as stoats and cats as well as in jumping squirrels–it helps them to make an accurate pounce on moving prey. Although other mammals may have overlapping binocular vision, it is the ability of the brain to perceive these signals as 3D images that is limited.

It is likely that other mammals perceive their surroundings in the same way as man does a picture or photograph. We find it much more difficult to judge depth using only one eye, in other words with monocular vision. Clues that help include the relative size of objects, the nearer ones appearing larger; the comparatively sharper outline and detail of nearer objects; the fact that objects further away appear to be higher up than nearer ones –seen very well if looking across a field of sheep. And finally, nearer objects appear to obstruct the view of more distant objects.

Three dimensional vision develops in conjunction with the other senses. Young kittens, for example, only develop normally and show themselves capable of hunting if they are raised in normal well-lit conditions where they can see their own body movements. In constant darkness their behaviour is abnormal and they appear incapable of using 3D vision if they are exposed to light. So not only must an animal have eyes, but it must also touch and smell the objects it sees to learn from its visual experiences.

Carnivores and herbivores The horse, a typical herbivore, has a wide field of view, the only area it cannot see being directly behind its head. It is sensitive to any movement across its view, although it does not have stereoscopic vision. Other senses, such as hearing, are therefore particularly import-

ant in detecting predators.

The forward-facing stereoscopic eyes of carnivores, such as the cat and fox or members of the weasel family, are constantly moving. These eye movements are accompanied by movements of the head so that different parts of the field of view move across the retina, stimulating the fovea and giving a more precise image than a herbivore would receive of the same situation.

Variations with light The eyes of some nocturnal mammals have no, or few, detail-sensitive cones. To allow maximum light to enter the eye the pupils are large, with large round lenses. This alters the overall shape of the eyeball which is elongated and tubular and cannot rotate so easily, so the animal needs to move its head constantly to maintain a visual grasp of its surroundings. The eyes of many nocturnal animals such as the cat have cells immediately behind the retina that contain reflective material. These cell layers (the tapetum) reflect the light that has passed through the retina, giving the rods another chance to be stimulated by any available light rays.

Man and squirrels have a colour filter built into their lens. A yellow tint eliminates some of the glare that comes from a bright blue sky and permits greater discrimination between shades of green. It also gives more precise vision.

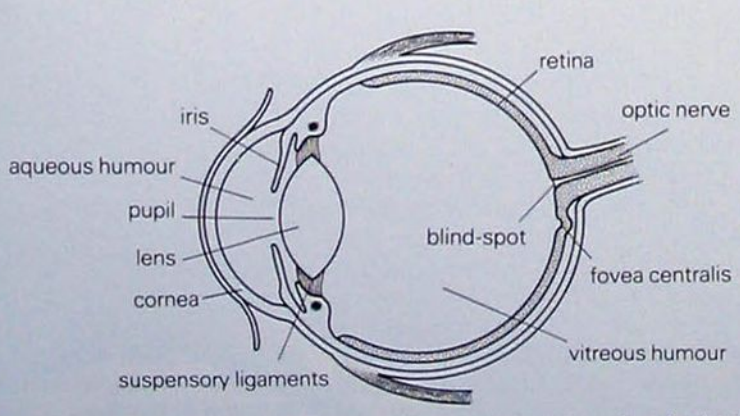
Vision and behaviour In addition to the more obvious uses of eyes for seeing food, predators or prey, and gaining information about the habitat, mammal eyes are essential for passing social signals especially between parents and offspring, and animals defending their territories or establishing hierarchies.

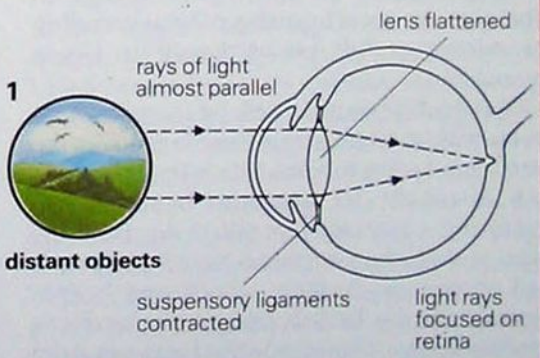
This is still a subject on which much work needs to be done before conclusive results can be shown.

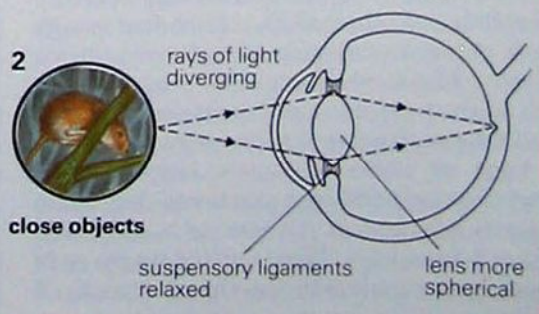
Above: Moles spend most of their lives underground and so sight is the least important of their senses, if indeed they can see at all. They show no reaction to sudden flashes of light.

Right: A grey seal is a mammal well adapted to hunting with eyes that can look upwards as well as from side to side and downwards. However, scientists have observed many blind grey seals in good condition which suggests that they can survive well even when they cannot see.

Mammal eye: structure and function







All mammal eyes have the same basic structure (above), whether they are the inefficient eyes of the mole, the highly efficient eyes of the squirrel, or man himself. They are set in depressions in the skull (orbits). Light rays are refracted at the cornea and the lens to focus on the retina. From here impulses travel along the optic nerve to the brain to be interpreted as images. The lens is flattened to focus on distant objects, and becomes more spherical to focus on near objects.

GAUZY-WINGED PREDATORS

Lacewings may be familiar in the autumn when they come into houses and sheds to hibernate. The delicate, attractive appearance of these insects belies their fierce and predatory nature, however.

There are about 54 different species of lacewings in Britain; they are known as Neuroptera or nerve-winged insects from the veined appearance of their wings. There are two common groups in this country–comprising about a dozen species of green lacewings and 29 species of brown lacewings.

Aphid eaters By far the most common and familiar of the British green lacewings is *Chrysopa carnea*. It is the only species to hibernate as an adult, the others spending the winter as full grown larvae in silken cocoons.

The adult's normal colour is yellowish-green with a white stripe running down the back, but during hibernation it becomes reddish in colour. Its wingspan is about 3cm (1⅛in) and it is about 1cm (⅜in) long. Both the adult and the larvae can be found on flowers and shrubs in gardens, woods and hedges throughout the British Isles as far north as the Shetlands. They consume large numbers of aphids and other small, soft-bodied insects such as small caterpillars and young scale insects. The larvae suck their prey dry, but the adults have normal chewing mouthparts and devour all parts of their prey.

Eggs on stalks A female lacewing lays approximately 500 eggs, each less than 1mm long and placed at the end of a thin stalk about 3-5mm long. These are laid singly, or in small groups, usually on the underside of leaves.

The eggs hatch in one or two weeks into active, voracious, spindle-shaped larvae. They have six legs and prominent curved mandibles which, along with the second jaws (maxillae), make a pair of sucking tubes to extract the juices of their prey.

Camouflage tactics The larvae have a very interesting characteristic; they bear rows of hooked spines on their bodies to which they attach the skins of their prey and other debris as camouflage. The older larvae of *C. carnea* do not do this, but in other species, such as *C. ciliata*, all the larvae are camouflaged and use the debris as a shield.

Suitable pieces of debris are selected carefully and held in the jaws. The larva bends its head back and, with aid of its front legs, fixes the pieces to its curved hooks. The abdomen is anchored while this takes place by a false leg at its tip.

When the older larvae are about 8mm (⅓in) long they secrete silk through their anus for their cocoons, which they spin in the soil or in debris at the foot of trees and bushes. After three or four weeks the pupae, which possess strong mandibles, cut through the cocoon and climb out. They then walk some distance before undergoing their final moult to the adult form.

Tree-top relatives The brown lacewings, another common group, are rarely seen because they are smaller and more inconspicuous than the other lacewings, and spend

Above: *Chrysopa carnea*, a green lacewing, at rest on an aphid-covered lettuce leaf. An insect of the evening and night-time, it will fly during the day if disturbed, with a slow, fluttering flight.

Above: The small brown lacewing *Hemerobius stigma* is found only in conifer trees. It has a wingspan of 15mm (⅝in).

Right: The giant lacewing (*Osmylus fulvicephalus*) can be found in numbers under bridges and also in bushes. It has a wingspan of 5cm (2in) and is 2cm (¾in) long; its size and its spotted wings make identification relatively easy. Like other lacewings, it usually rests by day on the underside of leaves.

much of their life high up in trees looking for the aphids on which they prey. Each species always seems to choose the same tree or trees for egg-laying. For example, *Hemerobius stigma*–a common species–always lays its eggs on conifers.

The female of this species cements her eggs between the scales at the base of pine needles (not on stalks). There is a succession of broods throughout the year, even in the winter, the eggs hatching in nine days in the summer but taking up to five weeks in winter.

The larvae are similar to those of the green lacewings, growing 7-8mm (⅓in) long, but they do not use camouflage. They have enormous appetites and can eat as many as 3000 newly hatched pine aphid nymphs before pupating. After a week or two in summer, but a little longer in winter, they spin silken cocoons among the pine needles. The pupae are active and the adults emerge after three weeks in summer. In winter, they may stay as pupae for some months, or emerge during a mild spell. Not all species of brown lacewing follow this life-cycle; most have just two broods in the year and overwinter as resting larvae or pupae, both protected in cocoons.

The adult brown lacewings are just as predatory as their green relatives. An adult female *H. stigma* kept in captivity for seven weeks is on record as having eaten no less than 17,500 pine aphid eggs and nymphs! The adult's stronger jaws enable it to eat the eggs and larger nymphs that are too tough for the larvae.

Above: The larva of a green lacewing attacking an aphid. It sinks its jaws deeply into the victim, lifts it up if possible, and then sucks it dry. It moults twice in the three-week period before it pupates, and consumes an average of 100 aphids.

Left: The female *C. flava* makes the stalk for her eggs by touching the leaf with a secretion as the eggs are being laid. She then lifts up her abdomen so that a viscous thread is drawn out. This hardens rapidly and the egg is left at the tip.

The biter bit Although both green and brown lacewings are predators, they are not without their own enemies. Parasitic wasps attack the larvae and pupae, and the larvae are also preyed on by ladybird and hoverfly larvae. They are even subject to attacks from their own relatives, the larvae of one species frequently eating the larvae of smaller species.

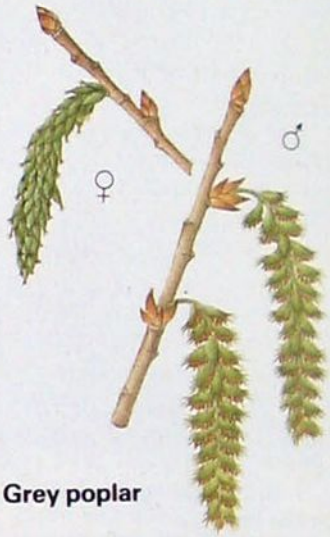
The largest lacewing The handsomest species of lacewing is the giant lacewing which occurs locally in colonies along woodland streams with dense bankside vegetation.

The male is unusual among lacewings in having scent glands which he uses to attract the female before mating. The female lays her eggs in May, June or early July on foliage near water. Only about 30 eggs are produced.

These hatch after three weeks into larvae of much the same shape as those of the other species, but with long, slender jaws that curve slightly upwards and outwards. The larvae use these to probe for the larvae of other insects, mainly midges, at the water's edge. They impale their prey, which quickly die from the effects of the poisonous saliva of the giant lacewing larvae.

The larvae overwinter before they are fully grown, finishing their growth in the spring. They spin their cocoons in April or early May when they have reached a length of 15mm (§in), and the adults emerge a month later.

White poplar



Grey poplar

DELICATE WHITE AND GREY POPLARS

For long, the decorative potential of the white and the grey poplars went largely unnoticed. Today, however, these trees are being planted on an increasingly wide scale, as planners and landscape architects come to appreciate their delicate beauty.

Above: A stand of white poplars just coming into leaf. Both the white poplar and the grey are planted for their ornamental value, particularly in rural areas where they are beginning to replace the Lombardy poplar in providing shelter and screening.

Both the white and the grey poplars are easily distinguished from other poplars by the presence of white down on the undersides of the leaves, especially those on long shoots. The effect is very pronounced on the white poplar (hence its name) and gives the tree a white cottony appearance from a distance.

The white poplar This is the smaller of the two species, growing to no more than 25m (80ft) high. The down covers the young shoots as well as the undersides of the leaves; indeed, when they first emerge the leaves are white all over, but the loose floss on the upper surface is soon blown off.

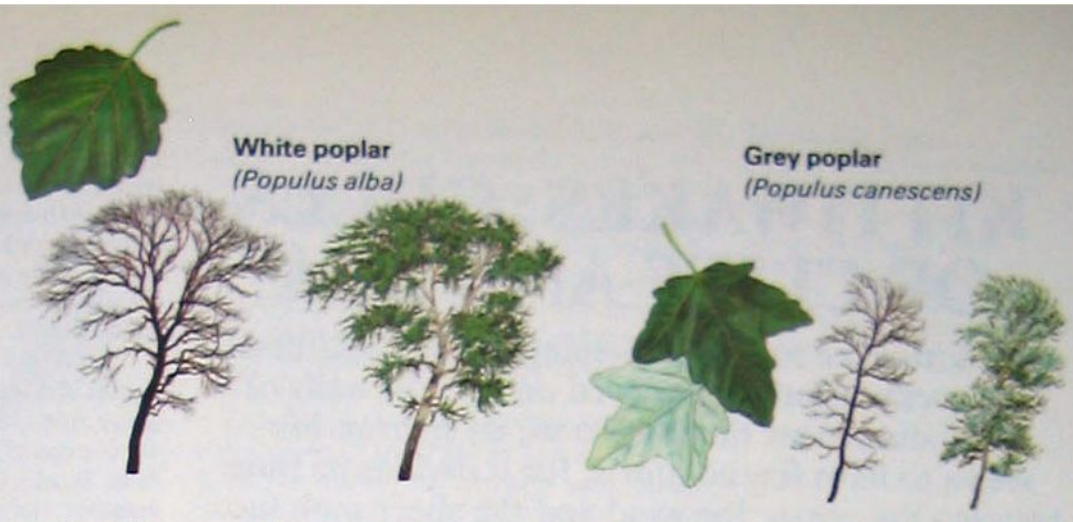
The leaves vary greatly in shape and size. Those on short twigs are broad and egg-shaped or rounded, with irregularly toothed margins. By contrast, the leaves on the sucker shoots, and those on young trees, are lobed and resemble maple leaves. This type of leaf also tends to be larger (4-10cm/1½-4in) compared with the former type of leaf (3-5cm/1¼-2in).

Each spring, the first sign of life in a white poplar is the emergence of its catkins. Male and female catkins are borne on separate trees, as is the case with all other poplar species. The male catkins are grey with conspicuous crimson stamens and the female catkins are green.

The bark of a white poplar is another feature that serves to distinguish it from other poplars (apart from the grey). On the lower half of the trunk the bark is furrowed and rough. Higher up, the bark becomes covered with small smooth areas of white to pale grey, interspersed with dark diamond-shaped pits.

As with so many poplars, the top of the tree tends to lean to one side. This is also often the broadest part of the tree.

Dutch import The white poplar is not native to Britain, nor does it grow here in the wild.



Left: The catkins of the white and grey poplars are very similar to each other, the males being grey with crimson stamens and the females green. Catkins of different sexes are borne on separate trees and emerge in March before the leaves.

It was brought over to this country from the Netherlands, probably sometime during the 17th century, though the records are vague about this. Its wild habitat is extensive, for it is found in central, eastern and south-eastern Europe, North Africa and across the steppes and plains of Asia as far as the Himalayas.

The grey poplar Unlike the white poplar, the grey poplar is naturalised in this country. It is most common in the Midlands and southern England. It is also found in scattered localities in Wales and Ireland. It is most often seen in hedges and woods, and tends to favour damp sites near streams and rivers.

No one is quite sure whether the grey poplar is native to Britain or introduced. However, in many areas there are far more male trees than females, which suggests that it has been planted in those parts.

There is also doubt about whether or not it is a true species. Today, most botanists think that the grey poplar is a hybrid between the white poplar and the aspen (another species of poplar). Certainly, it is intermediate between the two in appearance, and poplars do hybridise readily. Another point in support of this theory is that man-made hybrids between the white poplar and the aspen are indistinguishable from grey poplars.

Similarities and differences It is not always easy to tell the grey and white poplars apart. The best way to separate them is by the leaves on the sucker shoots. Those of the grey poplar are toothed but not deeply lobed, unlike those of the white poplar. In spring the down on the grey poplar is, as the name of the tree suggests, grey rather than the brilliant white of the white poplar. Also, on the grey poplar the down is less prominent on short twigs and on the undersides of the leaves.

The only other major difference between the two trees is in their shape and size. The grey poplar is a much larger and more substantial tree than the white, reaching a height of 35m (115ft) with a trunk up to 4m (13ft) in girth. The grey poplar is also more widely and extensively branched, and it does not develop the flat top that is often characteristic of the white poplar.

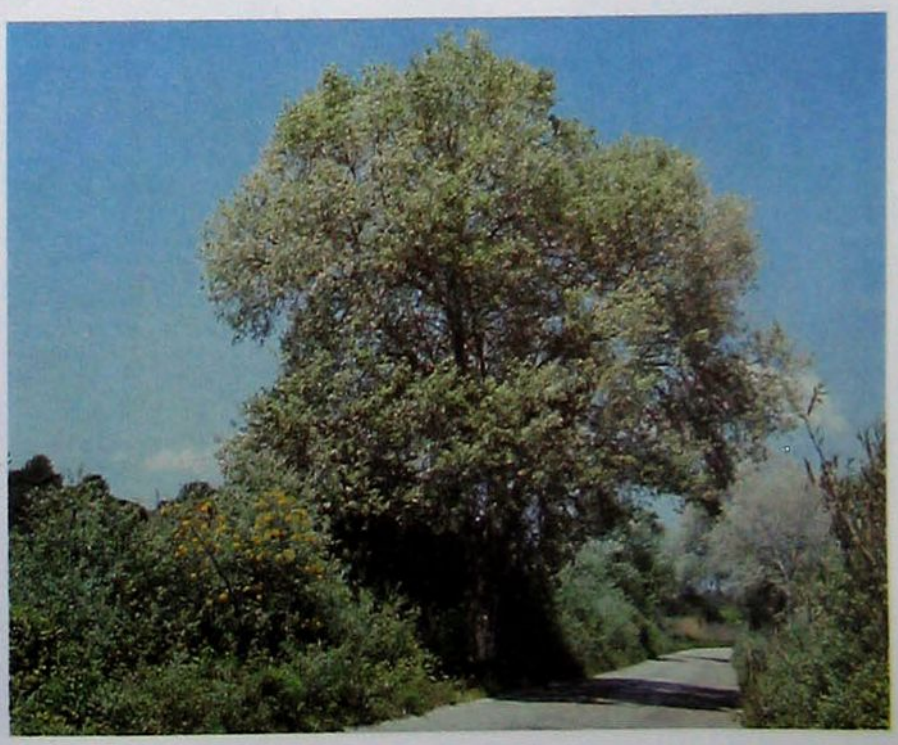
The catkins of the grey poplar are similar in appearance to those of the white, though they usually emerge a little earlier in the year. The trunk is also similar, the upper part being whitish to yellow-grey and smooth, apart from a scattering of dark diamond-shaped pits; the lower part of the trunk is much darker and ridged.

Landscape plantings Both the white and the grey poplars are being planted more and more as landscape trees. The white poplar has the advantage of being resistant to sea spray and so is one of the few trees that flourishes on cold windy sites near the coast. It grows better in the countryside than in towns.

The recent popularity of these two species is due to a concern among planners and landscape architects that they should be planting more native trees – or, at least, trees that 'look right' in the countryside. This movement has developed for reasons of conservation and aesthetics. The grey and the white poplars both merge well into the British landscape, with the added bonus of providing a beautiful texture and colouring. Compare these trees with, for example, the tall narrow Lombardy poplar, which so often looks out of place in our landscape, especially when planted in rows. So the white and grey poplars have an increasingly valuable role to play in our countryside.

White poplar (*Populus alba*). Deciduous tree, introduced to Britain from the Netherlands, probably during the 17th century. A slender tree, usually seen growing with a pronounced lean to one side; it is usually broadest at the top of the crown. Height to 25m (80ft).

Grey poplar (*Populus canescens*). Deciduous tree, probably a hybrid between the white poplar and the aspen. It is a larger, more widely branching tree than the white poplar. Height to 35m (115ft).



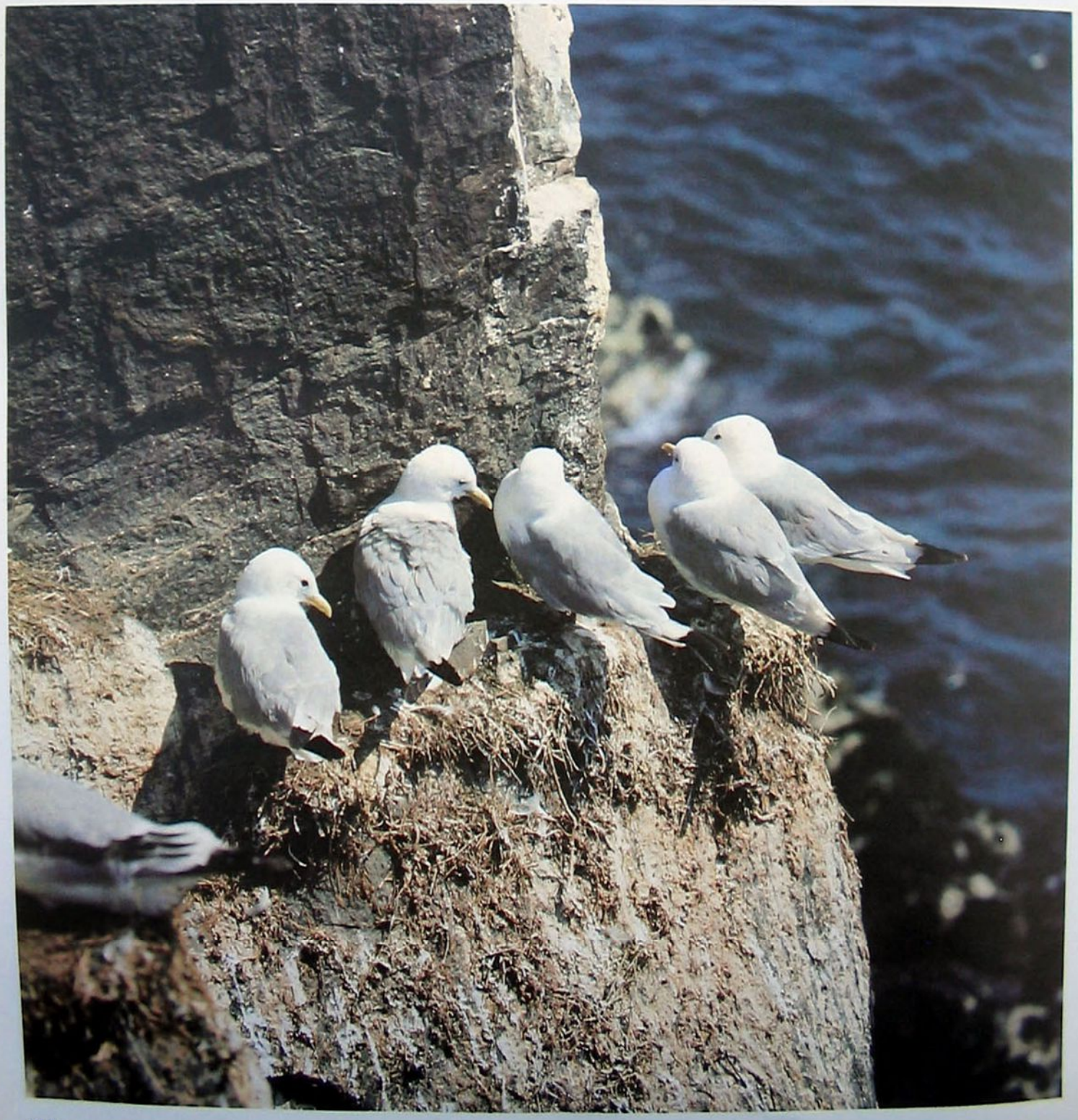
Below: A grey poplar growing in a roadside hedge. Hedgerows and woodland are the best places to find a grey poplar, particularly in damp land. Like the white poplar, it grows better in the countryside than in towns.

KITTIWAKES: GULLS OF CLIFF AND SEA

The kittiwake is an ocean-going seabird that nests on rocky coastlines, or even on vertical walls of buildings near the sea. To us, its spartan life seems to have few comforts, for it divides its time between the ocean, the wind and the sheer rock face.

The kittiwake, like the cuckoo, is an excellent example of a bird that clearly calls its own name. A raucous chorus of 'kitti-wa-a-a-ke' cries, with some variations on the theme, tells the birdwatcher that he is nearing a kittiwake colony. The sound is easy to hear despite the sound of waves breaking at the foot of the nesting cliffs.

The sound of the sea must be with kittiwakes all their lives, for in winter they fly far away from land, out over the Atlantic, and some even cross the ocean to the Newfoundland Banks fishing grounds. In spring and summer they can be seen almost anywhere round the coasts of Britain and Ireland, particularly where there are cliffs.



Kittiwake (*Rissa tridactyla*): small to medium gull that spends winter mainly at sea. Nests on cliffs, rarely seen inland. British population over ½ million, increasing by 50% every 10 years. Length 41cm (16in).

The kittiwake is by far the most maritime of our gulls, coming to land only to breed, and then restricted almost entirely to the coast. Only very occasionally are storm-driven or sick birds seen inland, seeking a last refuge on a large lake or reservoir.

A well-mannered gull Most gulls, though elegant, seem to humans to have an unpleasant side to their character: many are nest robbers, a few are even cannibals and feed on the chicks of their own kind, and most, given the chance, scavenge greedily on refuse tips. The kittiwake is a gull, but it has none of these unpleasant habits. It is classified separately from the majority of gulls, too, for it belongs to the genus *Rissa*, while most other gulls are grouped in the genus *Lara*.

The kittiwake is small and slender in comparison with most other gulls; it is all white except for the wings, which are silver grey with black tips. The wingtips differ from those of the common gull, which are also black but have clear white blobs that serve to tell the common gull apart from the kittiwake. The head of the kittiwake is small and rounded, and the beak is yellow, with a bright vermilion inside lining during the breeding season. The legs are black, further distinguishing the kittiwake from most other gulls.

Clamouring colonies On warm days during late winter, occasional single birds or groups fly in from the ocean to visit the nesting site, and visits become more frequent and prolonged during the spring. The more experienced pairs return to take up the territories they held the previous year.

Kittiwakes are primarily birds of the precipitous rocky coastline of western and northern Britain and Ireland. They nest in colonies, sometimes hundreds strong. The cliff they choose may be any size between a small outcrop to a towering precipice, and the kittiwakes are undeterred if the rock has the most intimidating overhang. Nests are sometimes built in the arch of a sea cave. The slightest projection or narrow ledge serves the bird as a foundation on which it can secure its nest.

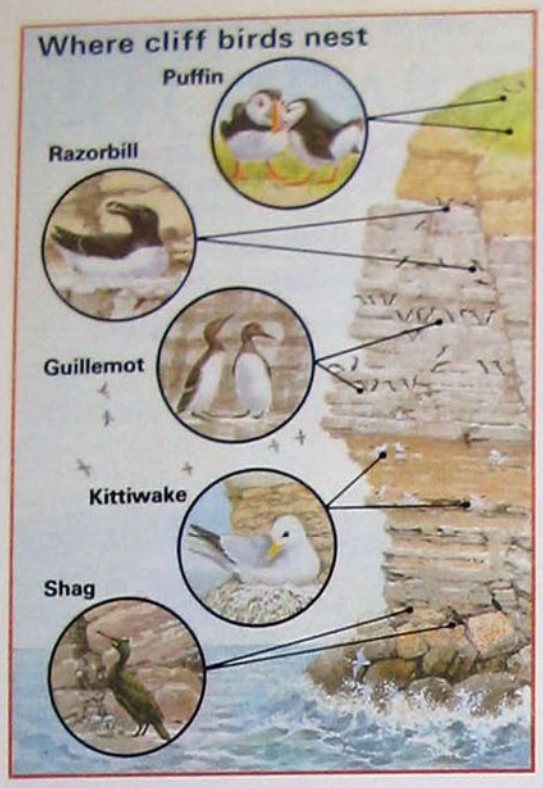
Each nest is about 25cm (10in) in diameter, and is made of mud, pieces of seaweed and a colourful variety of flotsam and jetsam, including fragments of fishermen's nets. All this is cemented together, more and more firmly as the years go by, with liberal quantities of the kittiwake's tacky droppings.

The eggs vary in colour from blue-grey to sandy-fawn, and are covered with darker brown speckles. Egg-laying usually begins late in May. Younger birds, breeding for the first time, have the least secure and most vulnerable nests, situated on the fringes of the colony, while more established pairs occupy the centre. Young pairs often lay only a single egg, while older birds have clutches of two or, somewhat rarely, three. Each pair breeds only once each season.

As they shared the task of refurbishing the nest before laying, so both sexes share the tedious period of incubation, which lasts 21-24 days. Often it is very hot on the cliff face, and the incubating adult can be seen panting, revealing the vermilion interior of its mouth.

Fledging takes between four and five weeks, depending on how stormy the weather is and thus how easy or difficult the kittiwakes' fishing flights are, for this determines the amount of food they are able to provide for the growing young. Because of the precarious situation of the nest, kittiwake youngsters have to be specially well-behaved. Until they are able to fly, they never walk more than a few inches from the spot where they hatched – if they did, they would risk

Below: Each time an adult kittiwake returns to the nest, its partner welcomes it with an effusive display, flapping its wings and bowing its head in an enthusiastic manner. Kittiwake colonies are always conspicuous because of the noise made by the birds after their return from the sea. First comes the raucous calling of the males during display, and soon after this the pairs make a great deal of noise defending their nesting ledges, and the nests themselves, from the depredations of their neighbours. Neighbourly relations may not be of the best, but as real fighting could easily dislodge eggs or young and send them tumbling into the sea, kittiwakes merely shriek at their neighbours if they come too close, adding to the bedlam of the cliffside colony.



a plummeting fall to certain death in the sea or on the rocks below.

Changing fortunes In the last century the fashion for ornamental feathers, and indeed whole wings of birds, as decorations on ladies' hats was at its height. The millinery trade demanded huge quantities of kittiwake wings–particularly the finely marked juvenile wings. Kittiwake shooting was regarded as a fine sport, and lucrative into the bargain. Thus by the turn of the century, the kittiwake was a scarce bird except in the most remote areas. The fortunes of the bird did not improve until it was given the protection of the law; once kittiwake shooting was banned, numbers began to increase once again.

Above: Young kittiwakes are not pure white like their parents, but have grey mottling. They also have a black half-collar on the nape of the neck and a black W-shaped mark across the outstretched wings. This is a useful identification feature of the juveniles in flight, as is the black band across the tip of the tail.

Below: Kittiwakes feed close inshore during the breeding season, and their diet is mainly small fish such as sprats. When out on the ocean in winter they feed on a wide range of small invertebrates, including jellyfish, crustaceans, molluscs and worms, that all float close to the surface in the marine plankton. Occasionally kittiwakes feed on plant matter.

Indeed, the kittiwake population has continued to grow for many years after the shooting was banned. One reason for their success must be that they have few natural enemies, and they are able to defend themselves well enough from those that they have, such as the larger gulls. If a gull appears at the colony, perhaps to raid a kittiwake nest, the whole community of kittiwakes mobs the intruder furiously. The siting of the kittiwake nests on the cliff wall ensures their safety from mammal predators such as rats, stoats or foxes. Another reason for the success of the kittiwake is that the small fish and plankton on which they feed are always plentiful throughout the year.

A census of the breeding population in 1959 gave the estimated population as 180,000 pairs, although this was considered an underestimate because of the difficulties of reaching and counting remote colonies in Scotland. A decade later the RSPB conducted a more thorough survey known as Operation Seafarer, which estimated the population to be just under half a million pairs. Even allowing for inaccuracies caused by the difficulty of obtaining data, it was clear that a phenomenal increase had taken place. Kittiwakes had recolonized all those coasts from which they had been hunted to extinction, and spread further afield as well. In eastern England, where much of the coastline is low-lying, kittiwakes had established breeding colonies on piers, warehouses and power stations, using vertical walls and windowsills as 'replacement cliffs'. There is no doubt that the kittiwake is now doing better than it has done for at least a hundred years.

Birdwatchers beware A kittiwake colony is well worth hours of watching, but be careful of two things: sit far enough away, so as not to disrupt the life of the seabirds, and, perhaps even more important, be careful for your own safety on the cliffs. Cliffs are always hazardous but seabird cliffs, with their coating of slime and thriving vegetation, are particularly dangerous. Beware of the temptation to crawl too near the edge to get a better view of a colony below an overhanging cliff. The ground could well be crumbly.

AQUATIC PLANTS: A LIFE UNDERWATER

Many plants flourish in still or slow-moving water in ponds, the shallow margins of lakes and in man-made habitats such as gravel pits and canals. The attractive flowers and foliage of some of the species are familiar sights in ornamental ponds.

Below: The water violet (*Hottonia palustris*) grows in scattered localities throughout England and Wales. Its attractive, yellow-throated lilac flowers, carried on erect stems up to 30cm (12in) high, bloom in May and June.

The water's edge is a boundary between two quite different environments: the land, where plants obtain water and nutrients mainly from below, and must find their own support; and water, where plants are surrounded and supported by the water itself and where nutrients are often available all around. Between the dry land and free water, all kinds of plants have found a home, adapting to their situation in various ways. Some species hardly differ from land plants; others are partially submerged, many with underwater leaves which differ from those on the surface; and yet others float on the surface or are completely submerged.

Adaptations to underwater life Underwater species often look very different from their land-dwelling counterparts. Since most of the plants' weight is supported by the water, they may have slender, weak and easily broken stems. In nutrient-rich waters, the minerals essential to plant growth can be absorbed over much of the plant's surface so the roots play a relatively minor role, often doing little more than anchoring the plant.

Carbon dioxide, essential for photosynthesis, is dissolved in the water and can be taken up directly through the leaves. Oxygen is a by-product of photosynthesis and appears as small silvery bubbles among the foliage on a sunny day. Gas exchange under water is less efficient than in the air, so the leaves are usually finely divided, or thin and very

numerous to give the maximum surface area. Finely divided leaves also cut down resistance to water movement and so minimise damage to the plants in moving water.

Aquatic reproduction Most of our aquatic flowering plants produce their flowers above the surface of the water to take advantage of the wind or insects to effect pollination. In some species, pollen is carried by the water, while in others new plants can be produced by fragmentation, an asexual method of reproduction. Stem fragments may be broken off by passing waterfowl or the drag of the current and carried to new localities by wave action or in mud on the feet of wading birds. Each fragment is capable of independent growth and can start a new colony. In this manner, aquatics can spread very rapidly, even if seed is not produced.

Above: The mare's-tail (*Hippuris vulgaris*) owes its name to early botanists who believed it to be the female form of the horsetail, a relative of the ferns. The inconspicuous flowers produced by the mare's-tail in summer help to distinguish it—the horsetail is a spore-bearing species, not a flowering plant. Water starwort (*Callitriche stagnalis*), shown at the bottom of the page, is aptly-named from its floating, star-shaped rosettes of leaves.

Water-milfoils Several species of water-milfoil grow in the British Isles, some native and some introduced. The two commonest native species are spiked water-milfoil, generally found in lime-rich waters, and alternate-flowered water-milfoil, which grows in peaty, lime-free water. The common name 'milfoil' probably derives from the French for 'a thousand leaves' and aptly describes how the whorled leaves of these species are finely divided into numerous segments.

In summer, water-milfoils produce inconspicuous flowers, carried in a spike above the water surface. The lower flowers are female and the upper ones, with larger petals, are male, although flowers in between usually have both male and female parts.

Mare's-tail, a relative of the water-milfoils, grows in ponds, ditches and slow-moving streams throughout Britain, particularly where the water flows over chalk or limestone. A creeping rootstock in the bottom mud gives rise to unbranched stems that rise above the water surface, producing tiny greenish flowers during the summer.

The aquatic primrose The feathery underwater foliage of the water-milfoils can be confused with that of the water violet but the species are easily distinguished when the flowers appear. The water violet is not, in fact, a violet at all but the only fully aquatic member of the primrose family in the British Isles. Although well adapted to life in the water, the flowers of this species need to be raised above the surface if successful cross-pollination is to occur. Nectar is produced by the flowers to attract the various insects that pollinate them.

Water pollinated plants The branching stems of hornwort, most commonly seen in still or slow-moving water, are covered with dense, bristle-like, forked leaves. The inconspicuous flowers, borne under water in the axils of the leaves, are found only on plants growing in warm, well-lit waters. The anthers of the male flowers, which contain the pollen,

Spiked water-milfoil (*Myriophyllum spicatum*). Flowers June-July.

Alternate-leaved water-milfoil (*Myriophyllum alterniflorum*). May-Aug.

Hornwort (*Ceratophyllum demersum*). Found S and E England to depths of up to 8m (26ft).

Curled pondweed (*Potamogeton crispus*). Often grows in ponds and streams with Canadian pondweed.

detach themselves and float to the surface where they burst and release the tiny pollen grains. The pollen slowly sinks back down through the water and if it should land on a female flower, pollination can occur.

In cooler waters, propagation of this species more usually occurs when pieces of the fragile stem break off and the fragments continue growing into larger plants.

Water starworts produce narrow, undivided leaves in opposite pairs under water, and most of the commoner species also produce rosettes of broader, floating leaves. The flowers are minute, green and without petals, arising singly or in pairs at the base of the leaves, usually only in the floating rosettes, from April to September. Pollen usually drifts from the male flowers to the female flowers on the water's surface, or is borne by the wind.

Plenty of pondweeds The dense, dark green foliage of the Canadian pondweed is completely submerged and is composed of undivided, stalkless leaves arranged in whorls of three around the stems. Canadian pondweed has separate male and female plants. The female flowers are commonly seen floating on the surface of the water, borne on long, slender stalks, while the male flowers are inconspicuous and produced at the base of underwater leaves. They are seldom recorded as the male plant is rare in this country.

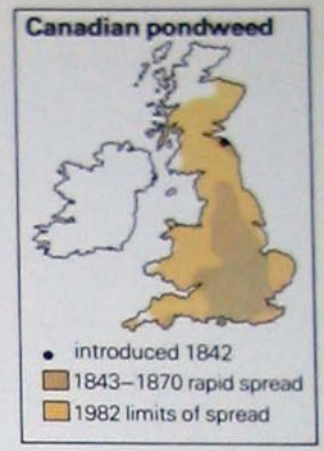
A closely related species which is becoming much more common each year is *Elodea nuttallii*. This species is very variable in appearance, with leaves in whorls of up to six. It can be distinguished from Canadian pondweed by its slender, narrowly pointed leaf tips and female flowers which are half the size of those of Canadian pondweed.

There are many varieties of the true pondweeds (*Potomogeton* species). Some species produce all their leaves under water, while others have leaves floating at the surface. The leaf shape varies according to the depth.

Curled pondweed is one of the most distinctive species. Its delicate, translucent leaves are crisped and curled at the margin and all submerged. Usually pale green, the leaves may become reddish-brown in deeper waters.

One of the commonest species, broad-leaved pondweed, has wide leaves that float on the surface of the water and are jointed at the base where they join the stalk. It can be confused with the amphibious bistort, which also has broad, floating leaves when growing in ponds or canals.

However, amphibious bistort has a different leaf structure, veins arising along the length of the midrib, not all from near the base as in the broad-leaved pondweed. As its name implies, amphibious bistort is just as much at home on land as in water, and has a terrestrial form with more erect, stouter stems and narrower leaves with shorter stalks.

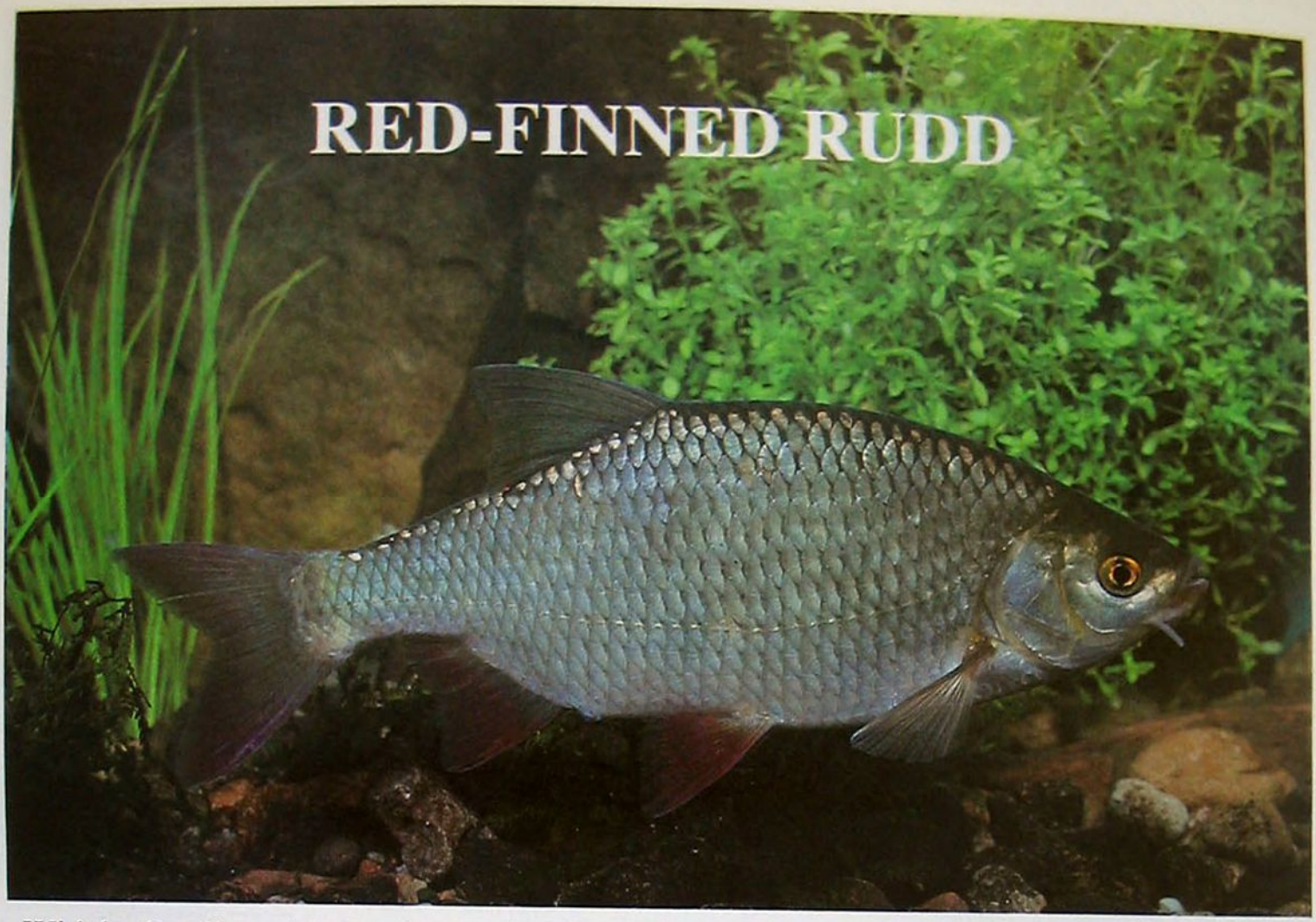


Spreading pondweeds

Female plants of Canadian pondweed (*Elodea canadensis*), shown above with *Elodea nuttallii*, were introduced to Ireland from North America in 1836. Their stems can quickly reach as much as 3m (10ft), producing such dense growth that they can block drains and obstruct waterways. First recorded growing wild on the British mainland in 1842, the species spread rapidly over the next few decades through much of central and southern England. Although this spread has now slowed, the accidentally introduced *Elodea nuttallii* is spreading even more rapidly and within the next decade it may have more or less replaced Canadian pondweed.

Above: The small, greenish flowers of broad-leaved pondweed are held above the water in a spike, supported by the floating leaves below. They are wind-pollinated and the fruits that develop may float a considerable distance from the parent plant on the water currents. Amphibious bistort (*Polygonum amphibium*), shown right, is sometimes confused with broad-leaved pondweed but the flowers on its spike are pink or red and insect-pollinated.

RED-FINNED RUDD



Above: The rudd (*Scardinius erythrophthalmus*) can grow to a length of 30cm (1ft) and weigh as much as 2kg (4lb 6oz). The word 'rudd' comes from the Saxon word 'rudu', meaning red, a reference to its fins.

Below: The rudd is native to lowland England but has spread via our canal system to many other parts of Britain. It has been introduced to Ireland, where it is now common and, rather confusingly, known as the roach.

Rudd distribution

Widely distributed in lowland Britain, though not often seen, the rudd is among the most brightly coloured of all our native freshwater fishes.

The rudd is a member of the carp family–a group of fishes which dominates the fresh waters of the Northern Hemisphere and includes the roach, dace, chub and bream among its British members. The rudd has all the basic features of this family, such as a scaleless head, toothless jaws, a single fin on its back and no sharp spines in its fins.

In common with many of its close relatives, the rudd has rather large, silvery scales all over its body, and it can look similar to at least some of them. In practice, distinguishing the rudd is usually easy because its fins are reddish; its pelvic and anal fins, in particular, are a deep scarlet. The colour of the iris in its eye is also a useful guide, for it is golden-orange with a red fleck on the upper side.

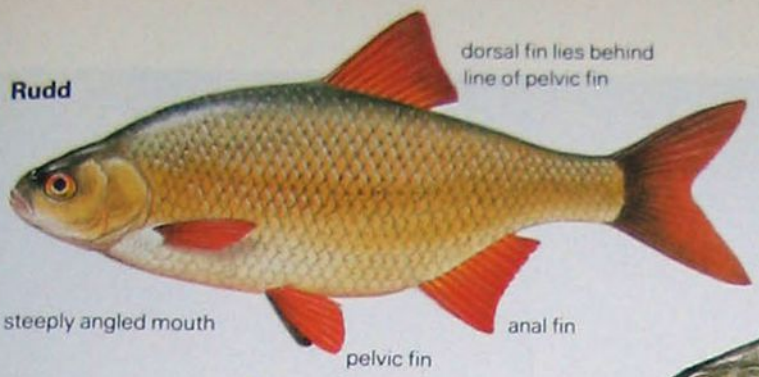
There are occasions when the rudd can appear similar to other members of the carp family, especially the roach, so other distinguishing features have to be looked for. In the rudd, the mouth is angled steeply upwards so that it opens almost on the upper surface of the snout; the fin on its back is placed behind the level of the pelvic fins on its belly; and its belly has a keel where the scales from each side of its body meet.

Lowland native The rudd is most common in East Anglia, south-east England and the Midlands, and it seems likely that it was originally confined to these areas, but it has now spread far outside its native range. This is due partly to the activities of anglers, who have taken small rudd to stock new waters and have also released rudd in the form of unused live-bait into these waters. Also, the building of canals has allowed it to spread from one river system to another.

The rudd is also a common fish in Ireland, though it is not native there. Confusingly, it is often called the roach in that country, since the true roach was unknown there until recently.

Still waters Rudd thrive in still or nearly still waters, for example, lakes, canals and slow-moving lowland rivers. Typical rudd habitats are Fenland drains, where submerged and emergent plants have been allowed to grow, and oxbow lakes as well. Unfortunately for the rudd, both habitats are anathema to the river engineer, who is for ever clearing the former of vegetation and draining the latter to reclaim land for agriculture.

Within a particular habitat, the rudd is almost always to be found close to cover provided by vegetation. For example, in large lakes it is usually found in shallow bays



Above: All the fins of a rudd are reddish and its pelvic and anal fins are often a deep scarlet. Its eye has a distinctive golden-orange iris, with a noticeable red fleck on its upper surface.

Below: On a roach, the fins are a dull grey-brown, apart from the pelvic and anal fins, which are orange to bright red. Its eye has a red iris.

where shelter and the depth of water permit plants to grow. The reason for this is that the rudd spends a lot of time close to the water's surface, feeding on insects. This makes it vulnerable to airborne predators, a risk that is minimised by staying close to cover.

Insect feeders Insects form the most important part of the rudd's diet. Larvae, pupae and adults of midges, flies, beetles and caddis flies are all taken. These are found either at the water's surface or among weeds, depending on the particular species.

Occasionally, the rudd eats small fishes, especially sticklebacks, and the fry of roach and even rudd itself, but this is exceptional. Large individuals also eat plants, from filamentous algae to pond weeds. Yet, although the plants seem to be eaten deliberately, there is considerable doubt whether much is actually digested.

Spring spawning In late spring, usually between late May and mid-July, spawning takes place. Occasionally, spawning may occur earlier in the year, depending on the temperatures and the siting of the lake. The critical factors seem to be water temperature and day length – if the temperature rises to 16°C (61°F) and the summer solstice is close, spawning begins.

The spawning sites are shallow weedy bays. The males arrive there first and form restless shifting schools which, once the females arrive, begin driving and chasing the ripe females towards the weeds. Spawning takes place individually, with one male (sometimes two) accompanying each female. The eggs are shed in large numbers (upwards of 100,000) over the weeds and, being slightly sticky, become attached to the leaves. Each egg is transparent and varies in colour from clear to pale yellow; its diameter is about 1.6mm.

Grazing larvae On hatching, the larvae are at first nourished by the yolk of their own egg but, within a few days, when they reach a length of about 6mm ($\frac{1}{4}$in), they begin to feed. Initially, they graze on single-celled algae that grow on leaves and probably also on minute organisms such as rotifers and protozoa. Within weeks they reach a length of about 1cm ($\frac{3}{8}$in) and start feeding on minute crustaceans, such as water fleas and copepods, that swarm close to the weed bed.

Crustaceans remain the most important food of the rudd for the first two years of its life. After that, it moves on to the typical adult diet of insects and plant material.

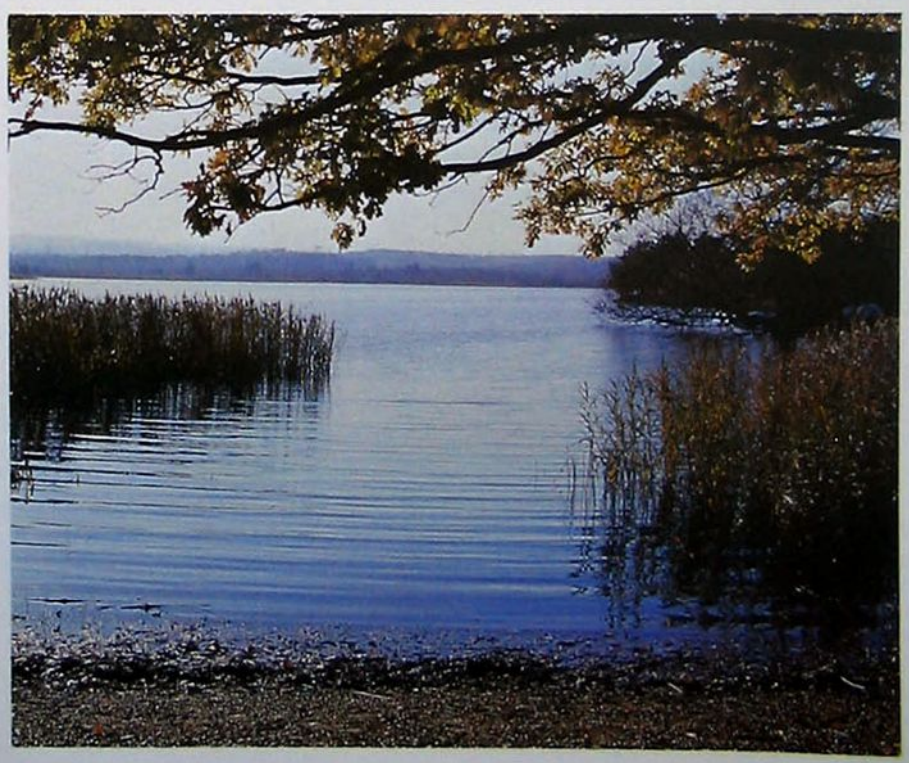
Rudd hybrids Two closely related fishes, the roach and the bream, both spawn over weed beds at about the same time as the rudd and often in the same sort of still waters. It is not surprising, therefore, that hybrids between these species frequently occur.

The roach × rudd hybrid is often very similar to the roach, but it sometimes looks rather like a pale rudd. The bream × rudd hybrid, on the other hand, always shows the bream parentage, with the long anal fin and deep body characteristic of that species.

On occasions these hybrids may be numerous. For example, out of a sample of nearly a hundred large fishes taken in Esthwaite Water in the Lake District, about a third proved to be roach × rudd hybrids.

Above: The distinctive red coloration of the rudd serves to distinguish it from most other British freshwater fishes, though confusion with the roach is still possible. Other distinguishing features in the rudd include its mouth, which is angled steeply upwards, and its dorsal fin, which lies behind the level of its pelvic fin. The roach lacks both these features.

Below: Lakes, canals and some lowland rivers are typical habitats for the rudd, since it thrives in still or very slow-moving waters. Favourite sites are shallow weed-ridden bays where the vegetation provides cover as the rudd feeds close to the surface.



THE SNOWDONIA NATIONAL PARK

The highest British mountains south of the Scottish Grampians occupy a region in north-west Wales whose ancient Welsh name is Eryri but which in English is called Snowdonia. Here, clustered compactly, are 14 peaks over 900km (3000ft).

Above: A view of snow-capped Snowdon (called Y Wyddfa in Welsh). It is an imposing 1085m (3560ft) high. The National Park, which takes in all the country from Conwy in the north to Aberdyfi in the south, was created in 1951.

The peaks of Snowdonia do not stand up as one solid massif; instead, they are divided into three blocks by deep, narrow valleys that became the trackways of early man and which our modern roads also follow. So, if you come into Snowdonia along the A5 from Shrewsbury you can see, from Llangollen onwards, how the land rises and strengthens all the way until, just after Capel Curig, you can look up at craggy summits whose steep flanks face you like a barrier. But the road, skirting Ogwen lake, soon finds a way through and drops down Nant Ffrancon, which is a text-book example of a glacier-smoothed valley. Indeed, the whole Snowdonian uplands make the Great Ice Age seem quite a recent event. Everywhere you find evidence of the action of ice and frost: shattered cliff faces, scratched rocks, perched boulders, U-shaped valleys, hanging valleys and many glacier-scooped lakes.

When the National Park was designated in 1951 the name Snowdonia, which originally meant simply the mountain of Snowdon itself and its sister peaks and the valleys immediately around them, acquired a new dimension. The Park took in all the 80km (50 miles) of country from Conwy in the north to Aberdyfi in the south; and east-west it reached for 56km (35 miles) from Bala to Tremadog – an area many times greater than that of Snowdonia in its traditional meaning. Now, when we speak of the mountains of

Above: Over 300 million years of erosion have removed enormous quantities of Snowdonia's softer, sedimentary rocks and left the tough, volcanic rock of the summits, which look out across deep valleys. The soils formed from this erosion are generally lime-deficient, but here and there small pockets of sedimentary soils remain and are colonized by such lime-loving plants as this attractive moss campion. Elsewhere a moorland type of vegetation is common.

Snowdonia, we mean not only Snowdon, Glyder, Carneddau, Hebog and Siabod, but also the many heights that lie further south–Moelwyn, Arennig, Aran, Cader Idris, Rhinog and the lesser ranges. In addition, the Park comes right down to the western coast of Wales and includes a complete range of lowland habitats–saltings, sea cliffs, sand dunes, farmland and broad-leaved woodland.

Mountain plants and birds The soils that formed from the erosion of Snowdonia's rocks are mostly deficient in lime and on them a moorland type of vegetation is common. But here and there are a few corries (circular hollows in mountainsides) and cliffs, some of sedimentary, some of igneous (volcanic) rocks, that are rich enough in lime to support a great variety of lime-loving plants, many of which are species better known in arctic or alpine regions of the world. Typical of these species are moss campion, purple saxifrage, starry saxifrage, mountain sorrel, roseroot, holly fern and green spleenwort, but there are many others. The Snowdon lily is one rarity that flourishes in just a few places.

Birds are not abundant in the mountains. But almost every corrie has its pair of ravens, and some also have peregrines. Choughs feed in these high places in summer, and ring ouzels breed on the heathery rocks, while screes are the chosen home of wheatears. In many a gully, however, the only bird sound you will hear is the startlingly loud song of the wren.

Birds of moorlands are likewise few in species. The most obvious and widespread are buzzards and carrion crows, while skylarks and meadow pipits are the most numerous. There are local populations of snipe, lapwings, curlews, black-headed gulls, mallard and teal.

Lakes and streams Though a few of Snowdonia's many lakes have been turned into reservoirs, most have been little altered by man, except that some have had alien fishes put into them and others have long ago lost the woodlands that surrounded them. The upland streams, too, retain their pristine

Below: The vegetation of Snowdonia's moorlands and summits is only semi-natural, being controlled by the grazing of sheep and, locally, by feral goats, as shown here.

populations of fauna and flora.

Characteristic of shallow lakes with gravelly beds are those underwater plants that grow as rosettes of green leaves – shoreweed, quillwort and lobelia. In a few lakes, such as Llyn Idwal, you may also find the little crucifer called awlwort and a minute unfernlike fern called pillwort. Muddier shallows are usually choked with bottle sedge and horsetail. Sheltered parts of the lakes may develop surface plants such as water lilies, crowfoots and floating water-plantain. On the squelchy margins of the lakes you may find bog bean, bog asphodel, bog mosses (Sphagna) and the insect-eating round-leaved sundew.

Practically all the lakes and streams have acid water and a few are so sour (some of those on peaty moorlands for instance) that they have no fish at all. Most other lakes have at least a limited invertebrate fauna supporting a population of brown trout.

Snowdonia's richest natural lake, and also its largest, is a lowland one – Llyn Tegid at Bala. This fine water, which looks towards the commanding peak of Aran Benllyn in the west, has long been renowned for its large and numerous perch, brown trout and pike. It also has a number of other fishes, including salmon, roach, grayling (not usually a lake species) and gwyniad, a silvery fish about 30cm (12in) long and found nowhere else in Wales. The gwyniad lives in shoals, usually in rather deep water and, feeding on plankton, is seldom attracted by any angler's lure.

Snowdonia's other rare fish is the charr, which inhabits deep cold water and comes into the shallows to breed at the end of autumn, when the males turn red on their undersides (hence the Welsh name *Torgoch*, meaning 'red belly'). For centuries the charr has been known in only three Welsh lakes – Cwellyn near Beddgelert and the twin lakes Padarn and Peris at Llanberis. But in the last few years Llyn Peris has become part of the Dinorwic pumped storage hydro-electric project. It was temporarily drained and its fish removed (via a hatchery) to a nearby deep mountain lake called Ffynnon Llugwy where, it is hoped, they will survive for ever.

Above: The cool, wet, windy climate of Snowdonia's uplands, and the rather infertile, badly drained podsols, do not encourage many wild flowers; nevertheless a few manage to survive, including this common tormentil, and also heath bedstraw and heath milkwort.

Below: A touch of distinction is given to Snowdonia by a rarity – the Snowdon lily. Merely a few centimetres tall, with small white flowers and grass-like leaves, this lily is found in Britain only on a few high cliffs of Snowdon, Glyder and Carneddau.

Sand dunes and sea cliffs Snowdonia's extensive sand dunes – they are on the coast of Cardigan Bay – have long been used as playgrounds for holidaymakers, golf courses and, at Harlech, as a site for growing conifers. But despite these activities (and military occupation in war-time) there are areas of duneland that remain almost completely natural (or as natural as the rabbits introduced in the Middle Ages allow them to be). Their very varied flora is rich in lime-loving species (the lime comes from the crushed remains of sea shells that are blown up off the beach with the sand.) Some species keep strictly to the drier places, while others prefer the sandy hollows, called dune slacks, that are waterlogged or even water-covered all through winter.

In summer the dunes are fragrant and colourful with the flowers of thyme, lady's bedstraw, burnet rose, rest-harrow, hound's-tongue, lady's fingers, sea holly, sea spurge, bee orchids, marsh orchids, marsh helleborines and a variety of lovely grasses that bend in the wind. Because of their abundance of wild flowers, these dunes are the home of many butterflies, moths and other insects. And among nesting birds on the sands are stock doves (they breed in rabbit holes), ringed plovers, redshanks, oystercatchers, lapwings, snipe and black-headed gulls.

South of the Mawddach Estuary stretch the Park's only sea cliffs. They are small, soft and eroding and of little attraction to nesting seabirds. The most distinguished seabird colony is actually 6.4km (4 miles) inland, where cormorants have bred for centuries on the high crags of Craig yr Aderyn. Owing to the presence of lime-rich boulder clay, the flora of the sea cliffs is of special interest and includes a few early purple orchids, rock samphire and sea spleenwort, as well as many

Right: A view of Nant Gwynant in the northern part of Snowdonia.

Below: Most reserves in Snowdonia are managed by the Nature Conservancy Council, and a few by the North Wales Naturalists' Trust and the National Trust. Their aim is to protect the habitats. Among them are the coastal dunelands of Morfa Harlech and Morfa Dyffryn; lowland dolerite cliffs and screes (Coed Tremadog); summits, crags, mountain slopes, lakes and streams (Snowdon, Cwm Idwal and Cader Idris); and high moorland (Rhinog). A permit is required for most reserves. Details from NCC, Penrhos Rd, Bangor, and NWNT, 154 High St, Bangor (enclose sae).

Some nature trails in Snowdonia

1 **Lady Mary's Walk** (FC) Forestry exhibition above Gwydyr Castle, Llanrwst; 1.6km (1 mile) walk.

2 **Cwm Idwal** (NCC) 3.2km (2 mile) walk through the first National Nature Reserve established in Wales.

3 **Beddgelert Forest Trail** (NCC) Introduction to forestry and some of its problems; 1.6km (1 mile) walk.

4 **Coed Llyn Mair** (NCC) walk exploring the plant and animal life of an oakwood. 1.6km (1 mile).

5 **Cwm Nantcol Nature Trail** (NPIS) Picnic site on bank of Afon Cwm Nantcol, near Llanbedr. Short walk shows effect of glaciation on Nantcol Valley.

6 **Cefn Isa Farm Trail** (NPIS) 3.2km (2 mile) walk explaining the story of Welsh hill farming.

7 **Farchynys Woodlands** (NPIS) off Dolgellau/Barmouth road; typical Welsh oak wood; 1km ($\frac{3}{4}$ mile) woodland path.

8 **Dolgefeiliau Forest Trail** (FC) picnic site off Dolgellau/Trawsfynydd road; walks showing plants and animals and explaining land use.

9 **Ty'n y Groes Forest Trail** (FC) picnic site off Dolgellau/Trawsfynydd road; 1.6km or 3.2km (1 or 2 mile) walk through 50-year old forest.

10 **Precipice Walk** (NPIS) off Dolgellau/Llanfachreth road, along high sheep walk 4.8km (2 miles).

11 **Tanycoed Forest Trail** (FC) picnic site off Dolgellau/Machynlleth road; walks through plantations of varying ages. 1.6km or 3.2km (1 or 2 miles).

NPIS = National Park Information Service.

Above: The heathery rocks of Snowdonia's mountain heights are the breeding haunts of the ring ouzel. This bird, a relative of our common garden blackbird, can be recognised by the distinctive white collar round its neck.

common shore species.

Moorlands and summits Though they may seem truly wild country, the uplands of Snowdonia are for the most part only semi-natural because their vegetation is controlled by the grazing of countless sheep, and locally by feral goats as well. This grazing has two main effects: it eliminates some of the taller flowering plants and encourages the spread of short grasslands; and it ensures that the semi-uplands are treeless, for without this grazing the hills would be largely covered with broad-leaved woodland or scrub up to about 500m (1500ft), and still higher on slopes sheltered from westerly gales.

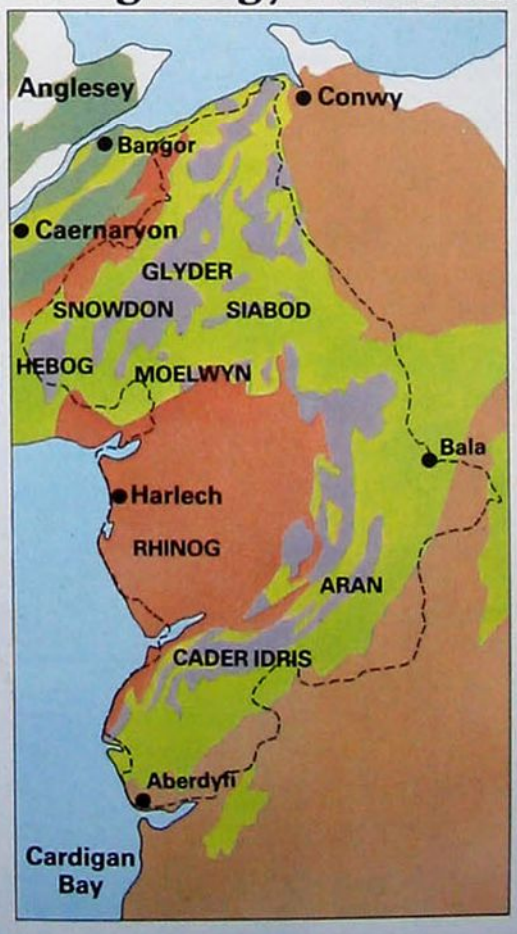
Much of the upland vegetation, growing on rather infertile, ill-drained soils (podsols) in a cool, wet and windy climate, consists of a few dominant grasses such as sheep's fescue, common bent and mat grass, among which a few low-growing but attractive wild flowers manage to survive; typical of these are tormentil, heath bedstraw and heath milkwort. Moorlands with a blanket of peat may be covered by a mixture of heather, bilberry, crowberry and cowberry. Wetter places can be white with cottongrass, hummocky with purple moorgrass or thick with rushes. Some bare summits and screes are thickly matted with grey spreading woolly hair-moss. Club-mosses of three kinds–alpine, fir and stag's horn–are widely scattered about the mountain turf.

This century the moorlands have been invaded locally by the spruce plantations of the Forestry Commission. Although quite alien, and destructive of upland habitats, these dense woodlands have to some extent been colonized by native species of flora and fauna. Notable among the birds are black grouse, goldcrest, coal tit, siskin and crossbill. And mammals that seek the shelter of the plantations include the rarest of all–the dark and furry pine marten.

Broad-leaved woodland The mixed forests of oak, birch, alder and ash which are believed to have covered the lower slopes and valleys of Snowdonia in prehistoric times have long since been reduced to pathetic remnants. Even today the destruction of woodland goes on, with hardly any planting of broad-leaved trees ever taking place.

Ecologically this loss of trees is a great disaster, for no land habitat has more species of flora and fauna than oak woodland. Even in the bleak, high-level woods of Snowdonia, where undergrowth is suppressed by the grazing of sheep, there is sufficient insect life to support quite numerous communities of breeding birds: tits, nuthatches, woodpeckers and willow warblers, along with the redstarts, wood warblers and pied flycatchers that are a special feature of these western woods. It is in such woodland, too, that most of the moorland buzzards breed, and also those ravens unable to find a suitable crag. Fox, badger and polecat are the characteristic mammals of these woodlands, and also the grey squirrel which, in the last 30 years, has replaced the red squirrel almost completely. Growing on acid soils the oakwoods have a lime-hating flora, and wherever there is dampness and shade there is a green world of ferns, mosses, liverworts and lichens, including many rare kinds.

The geology of Snowdonia



The rocks of Snowdonia are all very old (Palaeozoic). If you travel south-east from Anglesey you can follow them in order of time. Near Menai Bridge the pre-Cambrian rocks of Anglesey cross under the strait, but just before they reach the National Park they vanish under the Cambrian rocks. In a few miles these Cambrian rocks are lost under the Ordovician rocks which form the bulk of Snowdonia. If you continue on a south-east line and leave the Park near Bala you find the Ordovician rocks plunging in their turn under those of the next system, the Silurian, which forms a broad perimeter all round the Park's eastern and southern flanks.

- Silurian
- Ordovician sedimentary
- Ordovician volcanic
- Cambrian
- Pre-Cambrian
- --- National Park Boundary

WHAT'S THE POINT OF AGGRESSION?

Aggressive behaviour in mammals often looks much more dangerous than it actually is. Not to be confused with predatory behaviour, the object of which is to get food, aggression is for protection of territory, food and homes, and to find a mate.

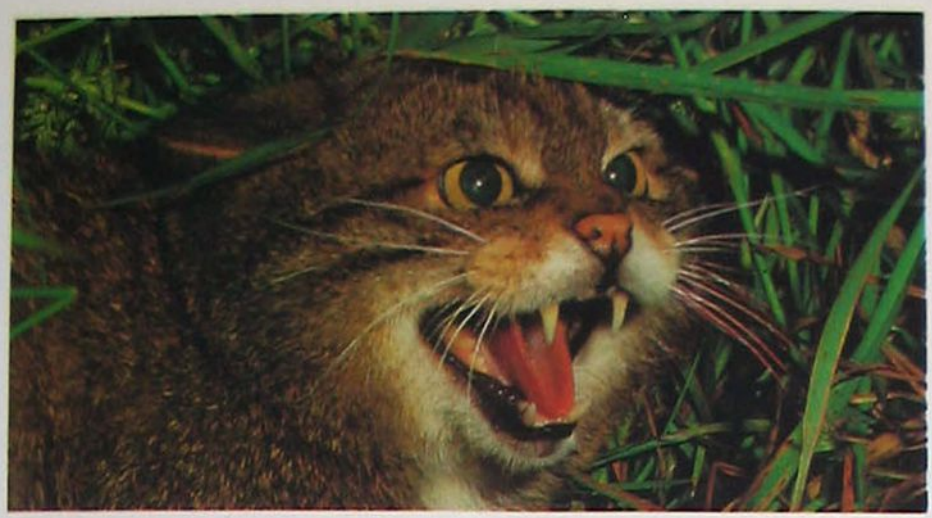
A red fox vixen, plagued by her over-exuberant cub, turns on him and displays aggressively, her tail raised as she utters screams and growls. The cub crouches in submission.

Aggression is a word that is loosely used to describe hostile or destructive behaviour in man, but when used scientifically to denote a certain type of behaviour in animals it has a precise meaning. People who keep pets or watch animals in the wild will easily recognise threats, quarrels and fights between the same species as aggression.

Aggression is not the same thing as predatory behaviour, as can be demonstrated by comparing a hunting tom cat with the same animal when it is threatening another male. In the first case it makes no sound as it approaches its prey with its body close to the ground. In the second, it stands with stiff legs and tail and utters a series of penetrating screams and howls. The results, too, are different: the successful conclusion to a hunt is that prey is caught, killed and eaten; aggressive encounters rarely end in death.

When aggression occurs All mammals show aggression at some stage during their lives, and it is an important aspect of their survival strategy. It takes place in defence of food, water, resting and nesting sites, and mates. Animals in competition for these resources are often members of the same species, so it is between them that aggression is most likely to occur.

It is to the advantage of animals that they settle their dispute as quickly as possible, thus saving their limited energy for other essential activities. Aggression must also be limited to



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Above: The photograph at the top shows a wild cat in an aggressive posture. Before this stage is reached it stares hard, then flattens its ears, then finally opens its mouth to show its teeth and let out an explosive spitting sound, accompanied by a howl (as in the illustrations above). The sound provides information about its size—the larger the animal, the bigger its resonating chambers and the longer its vocal cords, giving a deeper roar; and the frequency gives an indication of the wild cat's fitness and strength.

enable those that live together to do so in some harmony, particularly during the mating season and in those species that form social groups, such as badgers.

In many cases a preliminary level of threat is reached before the animals ever meet. This is known as territorial marking, which allows mammals to protect the resources within one area, and reduces the risk of fighting; it is tantamount to a sign saying, 'keep out'.

Limiting aggression One way the risk of actual fighting is reduced when mammals are in dispute over territory is by the use of signals in place of physical combat. They are graded in intensity, so there is a series of stages from mild threat to all-out fighting with opportunities at each level for either animal to break away.

When, for example, brown rats from different groups meet, they first pause; their backs arch, their hair stands on end; they gnash their teeth and approach each other, presenting the side of their bodies. Next they rear on their hind legs and, with noses almost touching, they begin to box. If one falls back, the other lies on top, and they remain motionless, except for the gnashing of teeth. Only after these stages does the biting and wrestling begin. Often this last stage is never reached because one rat gives up and is allowed to leave. If there is fighting, it seldom lasts for much more than a minute.

Mammals have many ways of demonstrating their weapons, size, strength and willingness to fight. The fox, for example, may display its teeth and snarl, curling its lips to expose the full length of the canines. As it snaps its jaws, and gnashes and chatters its teeth, it provides ample evidence of its ability to bite if it is further provoked.

Many animals draw attention to their size, and enhance it, by standing upright, erecting tracts of hair on their backs, and presenting a side view. Hoofed animals paw the ground, showing a willingness to advance. Others, like squirrels, chase each other. Sound is vital in animals with poor eyesight, such as shrews which scream at each other when they first meet. Weasels hiss, while badgers and cats spit. All these types of behaviour enable the animals to assess each other.

Fighting, like the various stages of threat, tends to be limited. Initial stages often involve boxing on the hind legs. Biting and wrestling are more serious and dangerous, because in using teeth to bite the vulnerable parts of the other animal's body, the neck and sense organs of both animals are at risk.

Agonistic behaviour Because opposing animals must have regard for their own safety, pure aggression is rarely seen, and elements of attacking and defensive behaviour are often mixed. This is described as agonistic behaviour. It is best observed in the animal's facial expressions and postures. Head bobbing, which is quite widespread, represents not only a forward attacking movement but also

Right: European otters engaged in mock fighting. Animals often pretend to be bigger, stronger or more willing than they actually are. But aggression can easily escalate, so bluff is an uncertain game.

Right: During the rut, red deer become extremely aggressive, vying with each other for mates. Their behaviour is often said to be ritualised, because they appear to struggle according to a set of agreed rules. In most cases the competition is a trial of strength which involves pushing and pulling. Devices such as the tines on their antlers help to prevent them from slipping sideways.
However passionate his sexual frenzy, there is little point in a strong animal winning the battle and losing the prize: the dominant males need to watch out for subordinate males who are quite likely to sneak off with the hinds while the harem masters are still fighting.

Above: A grey seal in a highly agitated state as she tries to defend her pup. The common seal can swim soon after birth, but the grey seal pup does not leave land for at least a month, and for the first fortnight it is totally dependent on its mother for food and protection. The mother seal barks at any intruders, showing her teeth.

a backward retreating movement. Agonistic behaviour also accounts for the arched back shown by animals such as cats when they are facing vastly superior opponents. It appears that the hind legs are advancing, while the more vulnerable front part of the body is in retreat, so that the body bends in the middle and seems larger.

The extent of aggression depends on the animal's needs. Pregnant and suckling females are particularly aggressive, and normally subordinate animals, such as female weasels, may become dominant at this time. Attendant males are also aggressive in defence of their young. Hunger and thirst produce aggression that may quickly escalate to fighting. This observation also explains why animals nearly always successfully defend their own territories against even stronger competitors. The owner has more to lose because he is familiar with the sources of food, water and bolt holes, and therefore he tries harder.

Peace in the feud Animals often establish a hierarchy so that one dominant animal has priority in choice of items such as food, resting places, water and mates, while the rest must wait their turn. Thus the strongest are most likely to mate and reproduce, and so the fittest survive.

Social hierarchy within a pack or group is established by threats and fights, and eventually the rest of the group show that they accept the winner's superiority by behaviour known as submission or appeasement. This often involves postures that are the opposite of aggression. Many mammals, such as dogs and foxes as well, crouch close to the ground, their tails between their legs; some roll on their backs, a posture that is often emphasised by the lighter colour of the animal's underside. Deer, such as the fallow and red deer, lie down with their necks outstretched. Other gestures include the grooming of the dominant animal, or adopting postures normally associated with receptive females or juveniles and infants. Appeasement gestures are also used between solitary animals when they meet each other.

It is tempting to judge an animal's behaviour from a human standpoint. A mother, of whatever species, protecting her young is viewed with admiration; an adolescent finding his position, with tolerance; and a dominant male, fighting off rivals, chivying females or scaring away juveniles, with condemnation. Such judgements made about animals that lack our powers of reason are meaningless. Aggressive behaviour is just a way used by animals to gain or keep what they need to survive or reproduce. It is both instinctive and learned from experience within the social group and from encounters outside. It is essential for an animal's survival.

PRIVETS NATIVE AND FOREIGN

The ubiquitous evergreen privet, so beloved for garden hedges, is a 19th-century import from Japan. Before its arrival, our own native privet, a deciduous shrub, had been used for hedging for hundreds of years.

Oval-leaved privet (*Ligustrum ovalifolium*). Evergreen shrub commonly planted for hedging. Height to 4.5m (15ft) if unclipped.

Below: Our native wild privet (*Ligustrum vulgare*) flowers in midsummer. It is no longer planted for hedging but can still be seen growing wild in parts of England. The best places to see it are the downs of southern and central England, though it can also be found in woodland. In a sunny site, it can reach a height of 3m (10ft).

Wild privet has been grown for hedging in Britain for the last 400 years–ever since someone discovered that its branches send out a compact mass of new shoots after being cut back. This behaviour made privet ideal for enclosing private gardens, especially where they were in close proximity to each other in towns and villages.

So familiar has privet become as a hedge that it is not always easy to recognise it in the wild. Yet, wild privet can be found in many parts of the country.

Privet habitats Wild privet is a deciduous woodland shrub, native to England south of the Humber and to a few scattered areas further north. It used to be a very common shrub on the North and South Downs, where it formed thickets by layering and sending out suckers, and it can still be found in those parts. It also occurs on downland cliff faces along the coast of southern England.

Other places in England where privet can still be seen growing wild include woods around Rothamsted in Hertfordshire, Oxfordshire woodlands where the English oak is predominant, the chalk scrubland of the Chiltern Hills and the wolds of Yorkshire and Lincolnshire.

Much of the old habitats of privet have been lost as land has been claimed for agriculture, but the shrub is still likely to be seen where old associations of ash and oak woods have been allowed to remain and the soil is chalky clay. Although privet prefers chalk or limestone soils it tolerates most other types of soil and it stands up well to the dust and grime of industrial towns, a fact that explains its popularity as a hedge shrub.

Deciduous shrub Although the wild privet is deciduous by habit, in a mild winter it often retains a few of its leaves until spring. By the time they drop, the new season's leaf buds are beginning to develop. Privet leaves are borne on short stalks and are narrowly lance-shaped, up to 7cm (2½in) long. Their margins are entire, with the upper surface a shiny dark green and the lower surface a pale green. In the autumn they turn a dull unattractive violet.

The leaves are set in opposite pairs on the twigs, which are olive-green and hairy. It is the strong rapid growth of these twigs that makes privet such a suitable shrub for hedging. In contrast to the young twigs, the main stems and the branches–even the small ones–are grey and smooth.

Panicled flowers Privet flowers are dull white or ivory and appear in late June and early July on stiff erect panicles about 5cm (2in) long. Each flower consists of a funnel-shaped tube that divides into four petals; inside are two short stamens.

Nectar is secreted at the base of the tube and is out of reach to short-tongued insects, particularly since the stamens block much of the tube. Long-tongued insects, however, including honeybees, can reach past the stamens and drink the nectar. In doing so, they rub against the stamens and pick up pollen. This is then transferred to another privet bush as the insects continue feeding, and so fertilisation is effected.

Privet flowers give out a distinctive, sickly smelling scent which many people find objectionable at close quarters. On the other hand, some find the smell pleasant and liken it to almond or hawthorn blossom. Beekeepers say that honey taken from bees that have fed exclusively on privet has a fishy taste.

Egg-shaped berries The fruit is an egg-shaped berry, olive-green when immature and ripening in September or October to become shiny black with a purplish bloom. Each berry is about 7mm ($\frac{1}{4}$in) long and contains one or two oily seeds, as befits a plant belonging to the olive family. The seeds are enclosed in a spongy violet pulp which has a bitter flavour and, in quantity, is poisonous to humans. However, birds such as thrushes, blackbirds and bullfinches eat them during a harsh winter, though in mild conditions they are likely to ignore them until other more palatable berries have disappeared.

Oval-leaved privet Until the 1880s, our native privet was widely planted for hedging throughout Britain. Then a new species of privet, the oval-leaved privet, was introduced here from Japan. This plant soon superseded the wild privet as a hedge shrub because it has the important advantage of being evergreen and so stays attractive and effective as a screen throughout the winter.

Two further advantages of the oval-leaved privet are that it adapts itself to a wider range of soils and conditions than the native species and that it grows faster. Indeed, it needs several clippings during the summer months to keep it in check.

Similarities and differences Broadly speaking, the two species are roughly similar, but with some differences. The leaves are the same size but those of the oval-leaved privet are glossy green on both sides and may have blunt tips. The flowers on this species are borne on much larger panicles–up to 10m (4in) long–and the fruits are larger.

Above: Many of the most popular hedging shrubs are cultivated varieties of the oval-leaved privet. Two of the most common are 'Aureum', with leaves a plain or variegated yellow (shown here), and 'Argentum', which has leaves with creamy-white 'margins'.

Below: An oval-leaved privet in March. Its evergreen leaves make this shrub far more effective than the native species for hedging during the winter.

Although the oval-leaved privet is called evergreen it can lose its leaves in heavily industrialised areas due to pollution, and during a particularly severe winter when the temperature drops to below $-12°C$ ($10°F$).

Uses and folklore Apart from hedging, the oval-leaved privet has no particular uses, but the wild privet, being native, has had a wide range of applications. The wood, though small in diameter, is hard and white, and highly valued by turners for making bobbins, spindles and pegs.

The juice of its berries was once used in dyeing, giving a blue, green or yellow dye depending on whether it was mixed with alum and salt, alum alone or alum and tartar.

A few centuries ago, herbalists used to distil the berries and the leaves to obtain a medicine that supposedly cured mouth ulcers; in the 18th century privet juice was used to improve the colour of an inferior port. But, bearing in mind the poisonous nature of the berries, neither of these uses is to be recommended today.

In folklore, privet has had an ancient tradition with youth, love and the moon, but any rituals that may have been connected with it have become lost in the mists of time.

PREDATORY MARINE WORMS

Few people are aware of the great diversity of worms to be found in the sea–far more than on land. Among the most advanced are a group of predatory worms closely related to the more familiar earthworms and leeches.

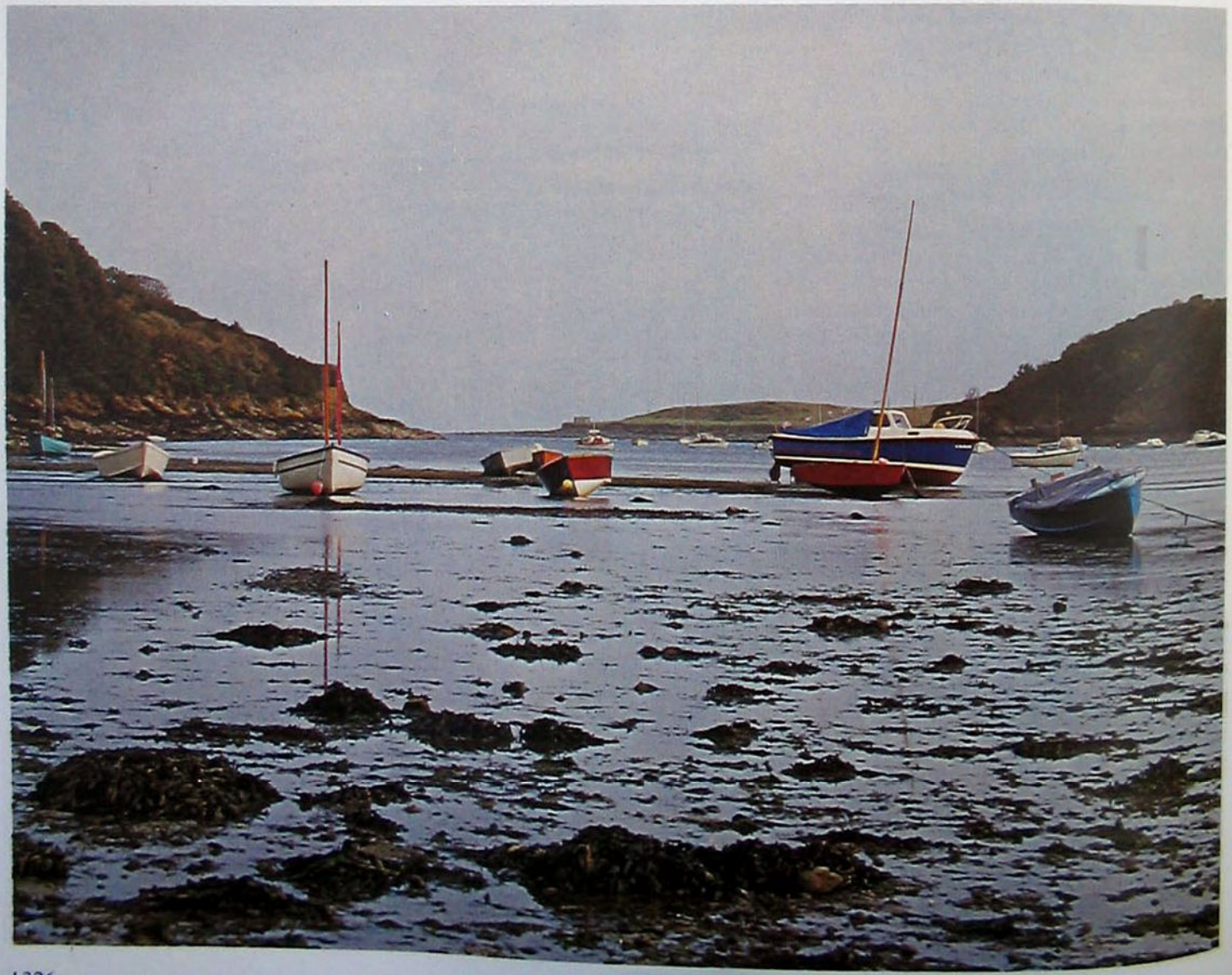
The animal kingdom includes a great variety of worms, both marine and terrestrial. The most advanced belong to a group known as the annelids; they are distinguished from the lower types by the fact that their bodies consist of segments separated by rings called annuli.

The annelids can be divided into three major groups. Two are familiar–the earthworms and leeches–but the third is a more obscure group consisting almost entirely of marine worms. This last group is known as the polychaete worms, meaning many-bristled. The name refers to the fact that each segment of a polychaete worm (apart from the head) carries a large number of long bristles called chaetae. Earthworms and leeches also bear bristles, though they are much shorter–almost invisible, in the case of the earthworm–and only a few are present on each segment.

Free-living or sedentary There are many species of polychaetes in the seas around Britain, but only very few are known to most people. Sea anglers, for instance, are familiar with two of our commonest species: the rag worm and the lug worm. These two species represent the two major divisions of polychaete worms–free-living worms and those that are sedentary. Here, we shall be considering just the free-living species.

The free-living, or errant, polychaetes are predatory and actively swim about in search of prey, unlike the sedentary types, which lead a more or less static life in a burrow or a tube. The fact that errant polychaetes are hunters means that they have a well-developed head with powerful jaws–as any angler who has been bitten by a rag worm will testify.

Errant polychaetes also have a more highly developed sensory system, which they need in



Below: An estuary at low tide is an excellent place to find marine worms. A wide variety of errant predatory types can be found here, including rag worms, paddle worms and the sea-mouse. This estuary is at Gillan Creek, St. Anthony in Cornwall.

Above: A species of rag worm (*Nereis* sp.). Distinguishing different rag worms is difficult since the colour of their bodies and their lengths can vary so much within a particular species. Usually, rag worms are reddish-brown to yellow or green, often with a thin red line (a blood vessel) running the length of their backs. The number of segments is usually around 100, but can be more than 150. The largest species is the king rag worm (*Nereis virens*) which can grow to 20cm (8in) long.

Below: One of the functions of parapodia is to aid movement. The rag worm uses them paddle-fashion for swimming, helped by flexing its body from side to side.

order to detect and catch their prey (typically, other small marine invertebrates). The mouth lies on the underside of the head and is in the form of a proboscis. The shape and features of the proboscis provide marine biologists with an important means of identifying different species.

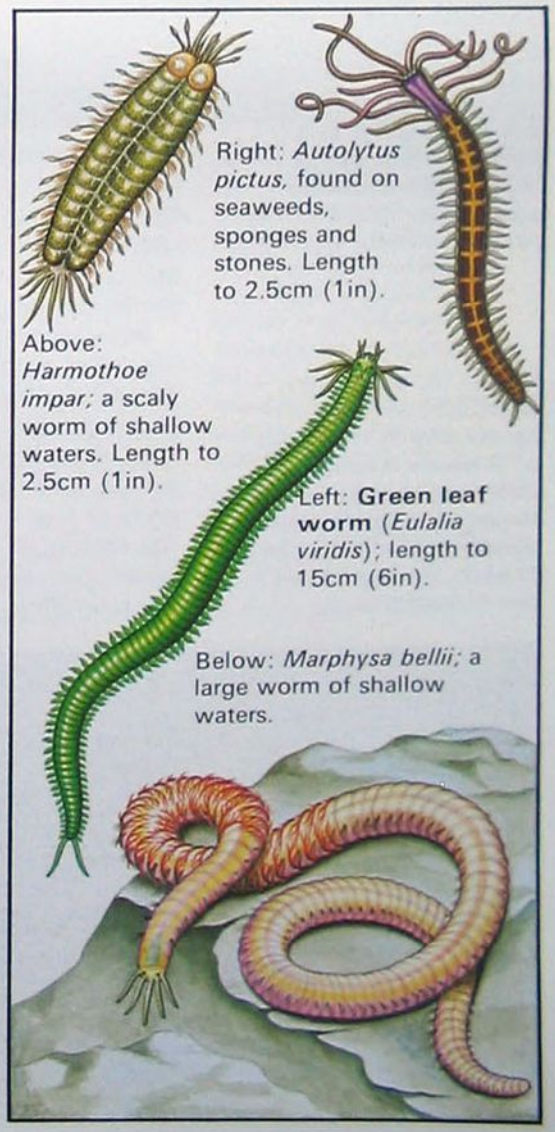
Paddle-like parapodia In errant polychaetes, the rest of the body after the head is fairly uniform, consisting of a series of segments, each bearing a pair of parapodia, one each side. These parapodia resemble paddles, or mini-limbs, and bear bristles, usually in two bundles, one pointing up and the other pointing down. Each segment, therefore, carries four bundles of bristles.

The parapodia are used by errant polychaetes mainly for locomotion. Each parapodium can be expanded by fluid pressure from the body cavity and are stiffened by minute rods of a horny material called acicula. This allows the worm to grip the substrate. To release its grip, the worm simply contracts the parapodia by muscles that pull them inwards. A further set of muscles causes the parapodia to be moved back and forth. Depending on the species, these movements allow the worm to crawl segment by segment or to swim by alternately contracting first one side and then the other of its body.

Parapodia for protection While the chief function of the parapodia is locomotion, in some species they have other uses. On the sea-mouse every alternate parapodium carries a scale which folds over its back to provide protection. These scales are covered with a thick mat of long iridescent bristles which, with its fat oval body, give this creature the appearance of a small furry mammal rather than a worm – hence its name. The sea-mouse is one of Britain's largest marine worms and can grow to a length of 20cm (8in). It lives on the surface of sand in shallow coastal waters around most parts of Britain.

A species closely related to the sea-mouse, *Harmothoe impar*, also has scales, but they are exposed rather than covered with bristles. *Harmothoe impar* is much smaller than the sea-mouse, growing to no more than 2.5cm (1in) long, and lives under rocks, stones and seaweed in shallow waters and the lower shore.

More uses for parapodia The parapodia on another group of polychaete worms, the



Above: A species of paddle worm (*Phyllodoce* sp.). Several different species can be found around the coast of Britain, some growing to more than 30cm (1ft) long. Notice this specimen's distinctive eyes and its large paddle- or leaf-like appendages after which the group is named.

paddle worms, have leaf-shaped extensions to aid walking. These are particularly clear on the green leaf worm, a bright grassy-green worm that can sometimes be seen crawling over rocks at low tide.

In most species of polychaete worms perhaps the most important other function of the parapodia is to act as respiratory organs. Inside each parapodium is a small network of capillary blood vessels which allow oxygen and carbon dioxide to be exchanged between the blood and the water or the atmosphere.

Separate sexes Polychaetes are single sexed – in other words, the males and females are separate individuals. Breeding is, for the most part, a simple affair. The eggs and sperm are shed directly into the sea and fertilisation occurs, leading in most cases to a planktonic larva (a free-living larva that swims close to the surface of the water). Some species increase the chances of fertilisation occurring by swarming together and releasing their eggs and sperm at the same time.

A few species, such as the green leaf worm, lay their eggs in a gelatinous green egg-sac about the size of a small gooseberry. These sacs can be seen attached to seaweeds or pebbles on the lower shore.

The larva metamorphoses into a young worm, typically after one or two months. Depending on the species, the larva is likely to remain planktonic and free-swimming for a while after, but it eventually settles on the sea-bed to begin the adult mode of life.

One or two families of marine worms remain exclusively planktonic all their lives.

Change of life-style A number of worm species change their shape and life-style when they are ready to breed – a phenomenon known as epitoky. The most familiar example of this among British species occurs in the common rag worm (*Nereis diversicolor*). This species spends most of its life on the middle or lower shore or on the sea-bed in shallow waters, but when it is ready to breed it forsakes the sea-bed or the shore and swims in the open sea. Its body also changes, the rear part developing larger parapodia with longer bristles. In this form, the common rag worm is known as *Heteronereis*.

A spectacular form of epitoky occurs in a tropical species, the palolo worm. At special times of the year when they are ready to breed, these worms become phosphorescent and swarm near the surface in huge numbers.

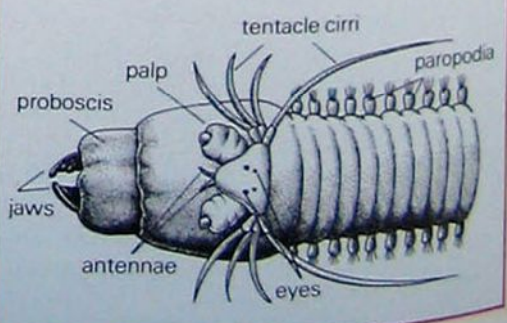
Below: The sea-mouse (*Aphrodite aculeata*) is named after its thick coat of iridescent bristles. The underside of its body clearly shows its segments with a pair of parapodia attached to each. On its head are a pair of antennae.

The head of a polychaete

Being predatory, most free-living polychaetes need to detect their prey and so have a much better developed head than the sedentary types. To this end, the head of a typical free-living species has one or more pairs of antennae, a pair of palps and several thread-like structures called tentacle cirri, which all help to detect movement in the water and provide the creature with a sense of smell and touch.

The mouth of a polychaete usually lies beneath the head, but for feeding it can be expanded forwards to project beyond the head and form a proboscis. The mouth is equipped with a pair of powerful jaws with which to catch the prey.

These various features can be seen particularly clearly in the head of a king rag worm, shown here with its mouth extended forwards for feeding.



SKYE-HIGH ALPINE FLOWERS

The flora of the Isle of Skye is rich and varied – in all of Western Europe there is no area of comparable size with such a range of types.

Skye is the largest of the Inner Hebrides group of islands, and a popular haunt with tourists. It is divided into six peninsulas, each with bays and promontories that make up 1450km (900 miles) of coastline.

In the dim distant past, molten lava from ancient tertiary volcanoes beneath the island's crust covered the landscape with a blanket of basalt, reaching a depth of up to 1300m (4265ft). The changes in the underlying rock were directly responsible for the varied landscapes of mountain, cliff and moor, as well as for the dramatic differences in soil conditions, micro-climates and plant habitats.

The Trotternish Ridge The flora is at its most fascinating near the north east coast of the island. This area is the Trotternish Peninsula with its long line of basalt cliffs looking east to the mainland across the crofting communities of the sea plain. The most exciting plants of this locale are the arctic-alpines which grow in and around the cliffs and summits of this ridge.

Here, the mountain flowers, spreading their carpet of bright colour down to low latitudes, are favoured by the cool, windy summers. Winters are mild – the icy blast from the north being moderated by the warm currents of the North Atlantic. Arctic-alpine flowers flourish in this part of Britain and can even be found at sea level. They have a charm all of their own – neat cushions of foliage covered

Above: The Old Man of Storr guards the southern reaches of the Trotternish Ridge, overlooking an almost alien landscape unparalleled elsewhere in Britain. Tall blocks and pinnacles of basalt tower menacingly, but provide a rich, nutrient-filled soil for the wide variety of plant habitats beneath them.

Below: A member of the pink family, moss campion (*Silene acaulis*), illustrates the cushion form typical of so many alpine plants.

in large, gaily coloured blossoms which appear soon after the ice and snow have melted, and set seed well before the gathering gloom of autumn.

At these low altitudes there is no long, tiring climb to find, say, the brilliant pink cushions of moss campion. The domed pads of dense, tiny leaves hug the ground, so cutting down wind resistance. High winds increase water loss, however, and make plants more likely to suffer from drought.

Here, too, can be found the delicate white flowers of mossy saxifrage. These also lie sheltered close to the ground, forming mats of tiny green shoots. The similarity of this foliage to that of some mosses gave this plant its name; it is a wild relative of the saxifrage found in rock gardens.

Adapting for reproduction On these wind-swept slopes wind-pollinated grasses and sedges are usually the most abundant plants. The beautiful alpine flowers in the form of open cups with pollen and stigma clearly displayed use their colours as a lure to attract insect pollinators. These need not be specific – any small creature crawling across the face of the flower will very effectively transfer pollen to the stigma.

Completion of this cycle of seed production and maturation during the short, mountain summer is one of the greatest problems for many alpines. Some plants have additional and special methods of vegetative reproduction to combat this problem. Viviparous (or alpine) bistort produces both a head with flowers at the top, and bulbils beneath. Some mountain grasses don't reproduce sexually at all, but produce vegetative propagules where seeds would normally form. Viviparous poa and viviparous fescue are examples of this adaptation, both occurring on the ridge alongside the bistort. The difficulties inherent in seed set are apparent in the fact that there are very few annual alpine plants – most of them are perennials.

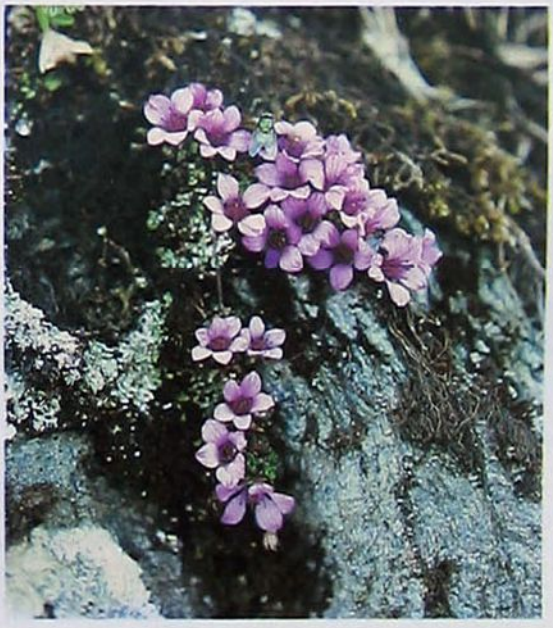
Alpine plants need anchorage and mineral nutrients from the rocks on which they grow. The basalt is rich in minerals and soft enough to weather into crevices for root penetration. As it fragments it releases the nutrients so essential for vigorous growth. With weathering, the rocks become unstable, then crumble and fall, so there are always bare patches on the cliffs where seeds can germinate free of competition from the parent plant. As the soaring cliffs are inaccessible to sheep, the plants can flourish and flower undisturbed by either man or grazing animals.

Valley protection In the larger gullies and crevices the vegetation is sheltered from the constant wind, so a large herb community develops. Here can be found flowers which are often seen in the rich pastures of lowland Britain, although in this alpine belt they are restricted to the most favourable sites with good soil depth and adequate moisture.

The lemon cups of the stately globe flower appear here, in contrast with the pink lanterns of water avens, which was once used as a preventative against plague. Later in the season, in July, these are replaced by the tall, white umbrellas of angelica, a plant named for its 'angelic' powers to ward off evil spells.

In many places streams cascade over the ridge and irrigate water gardens clinging to the rocks. Carpets of yellow mountain, starry, and golden saxifrage are common here. These species grow well when flushed by flowing water which brings a constantly renewed

Left: The foliage of the purple saxifrage (*Saxifraga oppositifolia*) grows to a height of 15cm (6in) flowering from March to May and sometimes again from July to August. A tenacious rock-clinger, it lends a refreshing touch of colour to the dark cliff faces.



Below: Another member of the family Saxifragaceae, the yellow mountain saxifrage (*Saxifraga aizoides*), loves water and can be found wherever there is a constant, mineral-filled stream.

Below: **Water avens** (*Geum rivale*). Flowers April to July.

supply of minerals.

Purple saxifrage flowers paint splashes of colour over the dark cliffs as March gives way to April. Their drooping branches with minute leaves produce large trumpets of purple even before the grasses and sedges don their green summer robes. In moist, rich hollows these are replaced by the spikes of the early purple orchid, which is common on the cliffs in May. This orchid is tolerant of the soil and climatic conditions found here and produces copious amounts of seed – two reasons why it is as much at home on these Scottish cliffs as on the short grass turf of the downs on England's southern coast.

Clinging to the ridge During late June, sunny dry crags are covered by a rare alpine member of the cabbage family, the northern rock cress. The flowers are white or tinged with pink, and here on the ridge they often appear to cling to bare rock, their roots penetrating deep into unseen fissures.

Damp scree slopes are the habitat for the tiny Icelandic purslane, in this its only known location in Britain. Although it was first collected on the Storr in 1934, the specimens were not identified until 15 years later. This little plant is easily overlooked and is perhaps most conspicuous late in the summer when its green leaves turn red. Icelandic purslane is one of the few annual alpines. Perhaps its success here on Skye reflects the mild island climate moderated by warm ocean currents.

Many beautiful ferns live on the cliffs and beneath. Two of these are among the country's most primitive species. The brown spores of the moonwort are grouped in clusters at the top of a delicate stalk rather than – as is more common – on the back of the leafy frond. The foliage of the lesser clubmoss is inconspicuous as it twines with grass and sedge. Here the spores are at the base of the leaves growing at the tip of the shoot. In the deepest, darkest cracks we can also find the sea spleenwort, a maritime member of the group of tiny ferns so named because of their use in olden times to treat disorders of the spleen.

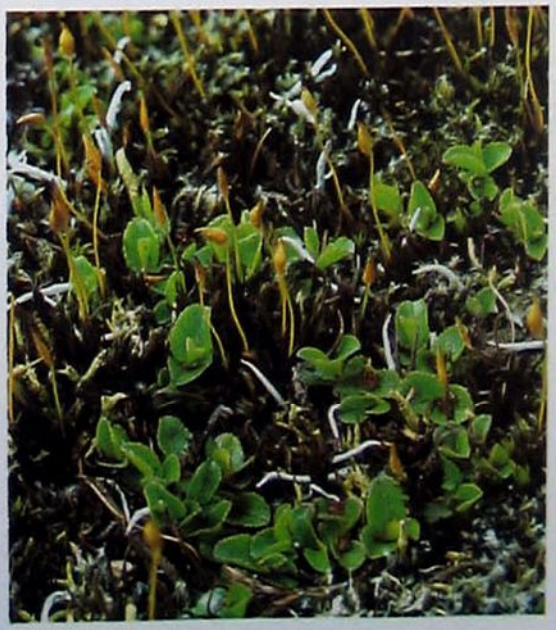
The ridge is separated from the sea by the coastal plain, but these crags have many flowers often associated with sea cliffs. Sea thrift, sea campion and sea plantain are common, their foliage lacking the usual succulence that is an adaptation to life by the sea.

Cliff-top exposure On the tops of the exposed summits the mountain flowers must lie especially close to the ground to escape the fierce wind. The tiny, white flowers of the alpine pearlwort grow here with the yellow-green cushions of mossy cyphel which is a true alpine plant. It is found elsewhere in Western Europe on the Pyrenees and Alps, but not in the Arctic, unlike most of our mountain plants, which are true arctic-alpines.

Our smallest British willow is common on the tops of the ridge. The foliage of the 'least willow' is quite different from that of the lowland willows, usually seen dipping their silvery branches into streams or lakes. This mountain willow has very short aerial branches with as few as two leaves not exceeding 2cm ($\frac{3}{4}$in) long. The catkins can be as large as the leaves and the whole tiny shrub lies so close to the ground that it can survive on the most exposed mountain summit.

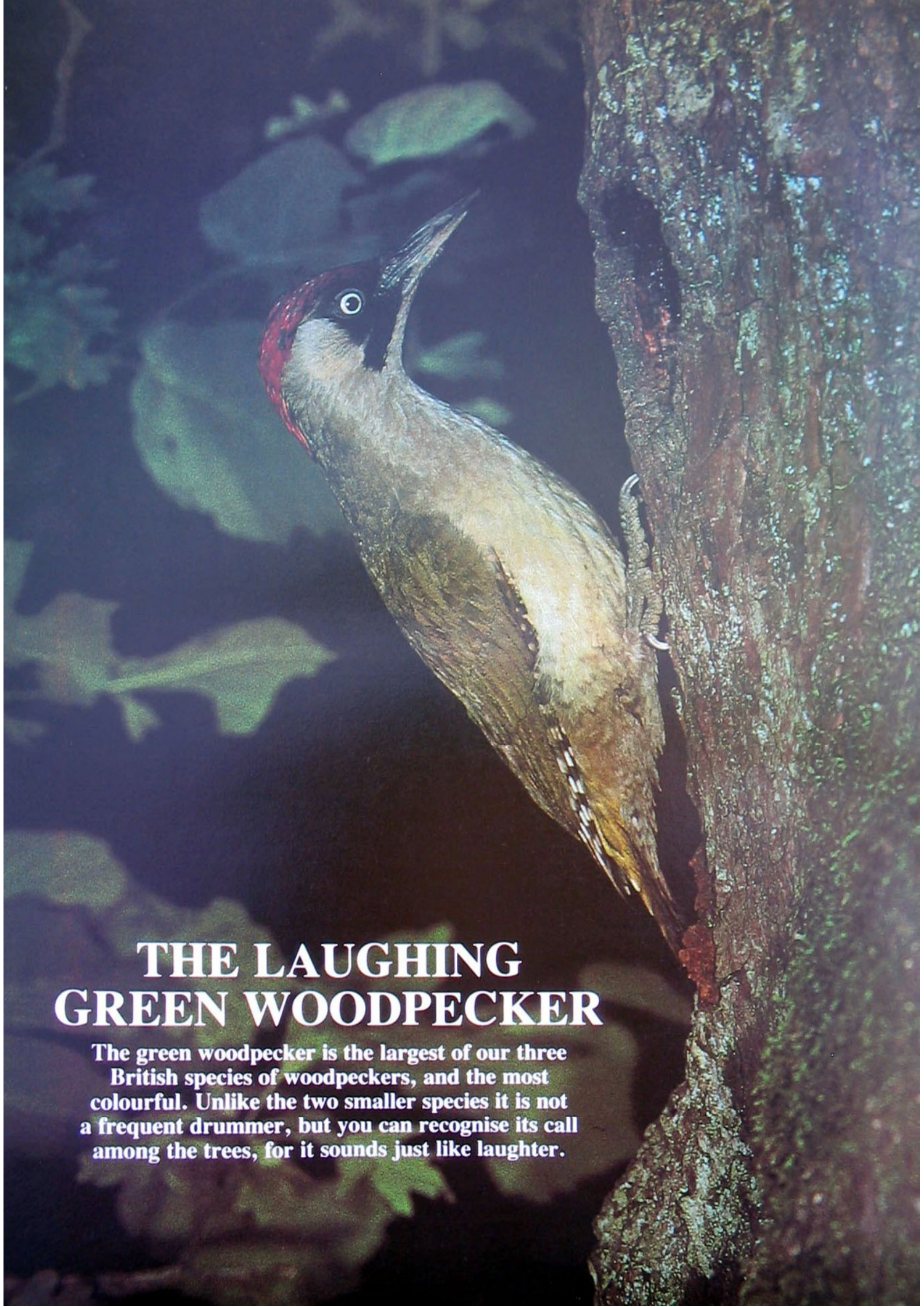
Above: Mossy saxifrage (*Saxifraga hypnoides burren*) is a perennial herb, and the wild relative of our commonest rock garden saxifrage. The prettiest alpines can be found in May and June before plagues of midges appear on the island.

Below: Looking remarkably unlike its better-known relatives, the least willow (*Salix herbacea*) grows close to the surface of the exposed ridges in order to survive the constant winds.



Right: **Alpine bistort** (*Polygonum viviparum*). Flowers June-Aug.

Right: **Moonwort** (*Botrychium lunaria*). Spadix spore cluster.



THE LAUGHING GREEN WOODPECKER

The green woodpecker is the largest of our three British species of woodpeckers, and the most colourful. Unlike the two smaller species it is not a frequent drummer, but you can recognise its call among the trees, for it sounds just like laughter.

English woodland plays host to three species of woodpecker: the great spotted, the lesser spotted and the green. All three species are dependent on trees as a habitat, for these provide them with nest sites and plentiful supplies of food. This they find by chipping away at bark to search for grubs beneath.

To live this kind of existence, woodpeckers need a variety of aids. To climb up tree trunks and branches, a woodpecker's feet have two toes pointing forward and two pointing behind, instead of the more usual arrangement of three toes forward and one behind. Also, the tail, which has very stiff feathers, acts as a kind of third limb, being pressed to the tree trunk to give further support. These physical aids enable woodpeckers to climb up, around and even backwards down a tree, all of this being accomplished with jerky movements.

Our largest woodpecker The greater spotted and less common lesser spotted woodpeckers are mainly black and white, and in length they are about 23cm (9in) and 14.5cm (5¾in) respectively. But the green woodpecker, as its name implies, is mainly green; and it is comparatively large at about 32cm (12½in) long. At a distance it appears generally green, but closer examination reveals that its back is darker than its buffish green belly, and that its rump is bright greenish yellow. The crown is a contrasting crimson, and the sexes can be distinguished by looking at the moustache-like stripe, which is all black in the female but is red with a black border in the male. Young birds are less brightly coloured, with pale spots on the green and black streaked underside.

The green woodpecker is a resident bird, rarely undertaking journeys of more than a few kilometres. This may explain why it has not colonized Ireland. It has only recently invaded the Lake District and Scotland. In Scotland, breeding was first recorded in 1951 and the invasion was two-pronged. Birds from north-west England moved into the counties across the Solway Firth, while their range in the north-east extended from Northumberland to the central lowlands of Scotland and up to Aberdeen on the east coast. Their progress northwards may still continue in future.

Green woodpeckers prefer open (and often deciduous) woodland to the denser stands of conifers. The open parklands and landscaped gardens that man has created in much of Britain are particularly favoured, so that people who regularly walk in such areas are familiar with the bird. It also commonly visits bird tables, and in doing so it adds conspicuous flashes of colour, appearing suddenly and moving jerkily in its yellow, green and red plumage.

Varied diet Its long and highly manoeuvrable tongue is useful for searching under loosened bark for grubs, but the green woodpecker also uses it to probe into short turf,

Green woodpecker (*Picus viridissima*): resident in England and Wales, spreading into Lake District and Scotland since 1950s. Call resembles a human laugh, a loud 'gua-gua-gua-gua-gua' from which its country name, the yaffle, derives. Length 32cm (12½in).

The main difference in appearance between male and female is in the 'moustache'. The female has a full black stripe, while the male's stripe has a red centre.

or into ant hills, in search of the abundance of food that these contain. In recent decades a number of open conifer woods have reached maturity in Scotland; these are inhabited by dense populations of wood ants, and this may have been one factor that made it possible for green woodpeckers to invade Scotland.

Ants are significant because they help to extend the range of the green woodpecker, but the birds have an extremely varied diet. They eat a large number of tree-inhabiting insects, especially the larvae of wood-boring beetles and gall-producing insects, and many caterpillars as well. Green woodpeckers have also been known to prey on other birds, especially nestlings. Tits, house martins,

Below: A young green woodpecker. The parents continue to feed the young for several days after they leave the nest hole, until they are independent.

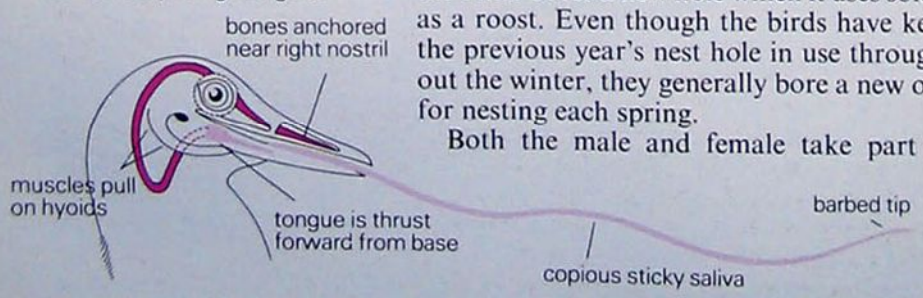
Above: Female feeding her young. The entrance to the nest is a passage about 5-7cm (2-3in) long, leading to the top of a chamber 30-40cm (12-16in) high, and up to 18cm (7in) wide.

Above: An adult female green woodpecker, with some of her plumage standing on end to dry in the sun, perhaps after a bathe. Dead wood, on which she is perching, often contains a wealth of grubs and other forms of prey for woodpeckers.

Right: Woodpeckers made this hole in an ants' nest and were frequently seen plundering ants from it. Green woodpeckers benefit from the presence of sheep and rabbits, whose grazing creates good conditions for ants to thrive.

How the tongue sticks out

Most vertebrate animals possess a pair of hyoid bones supporting the base of the tongue. Woodpeckers have extended hyoids that curve up behind the head. Muscles pull on the hyoids, giving a powerful thrust to the very long tongue.



house sparrows, starlings and even lesser spotted woodpeckers are occasionally eaten. They also eat eggs as well as acorns, hazel nuts, rowan berries and a variety of other seeds, berries and fruits.

New nests each year Out of the breeding season, green woodpeckers continue to use tree holes for roosting at night; one member of the pair roosts in the former nest hole, and the other bores a new hole which it uses solely as a roost. Even though the birds have kept the previous year's nest hole in use throughout the winter, they generally bore a new one for nesting each spring.

Both the male and female take part in the work of boring the nest hole. They normally cut their holes in decaying, rather than living, timber, although they often use decaying branches of living trees. The nest contains no lining material, except for a few wood chips that the birds do not remove, and the eggs are laid directly on the floor of the cavity. The eggs are white and oval, and normally number between five and seven.

Green woodpeckers breed between the end of April and June, but starlings pose a serious threat to those that nest early in the season. The starlings, in their search for convenient nesting places, evict the woodpeckers forcibly from their hole, and proceed to occupy it themselves.

In nests that escape these most unwelcome visitors, the green woodpeckers (both male and female) incubate their eggs for 15-17 days. After hatching, both parents feed the young, and it is during this period (about 20 days) that you can most easily detect a green woodpecker nest by the raucous calling of the noisy young.

Woodpeckers and man It may seem surprising that woodland birds such as green woodpeckers should have an important effect on the activity of man, but their habit of boring holes does cause difficulties. They sometimes damage shingle roofs by boring into joists and weakening them at least enough to cause a partial collapse. Telegraph poles, being made of dead wood, have obvious attractions for green woodpeckers; and where electricity cables are carried by wooden poles, the birds can damage them sufficiently to bring them down and cause a power failure.

On the credit side, some foresters believe that the green woodpecker is useful in removing insect pests from trees. Besides this, their preference for boring into decaying wood provides an early warning system for the forester – their activity shows him where to cut off dying branches. To the wider public, their colours and laughing call bring excitement to gardens and town parks.

LARGE-EYED LEAPING SPIDERS

Unlike most spiders, the compact furry bodies and huge eyes of jumping spiders give them a rather appealing appearance. They have great jumping powers, and hunt by stalking, and then leaping on their unsuspecting prey.

Above: A pale coloured male of the species *Evarcha falcata*. This is much magnified from its true size of 7mm ($\frac{2}{8}$in), and clearly shows the furry legs and body, and one row of large front eyes. The males are smaller than the females, but more brightly coloured and with massive front legs which are used in their courtship displays. They have quite a wide distribution around the country and are most commonly found in heaths and woodland.

Jumping spiders are a fascinating group of arachnids with several unusual characteristics. They have large eyes and furry bodies, and their alertness, visual abilities and jumping prowess makes them undoubtedly the most advanced family of spiders.

The scientific name of the family, Salticidae, is derived from the Latin *saltare*, meaning 'to dance' and refers to their jumping powers and strange mating ritual. Despite the fact that none of the species in this country has a body length of more than 10mm ($\frac{2}{5}$in), they are formidable predators of soft-bodied insects, aided by their powers of vision.

Spider vision Jumping spiders inhabit a far more visual world than do most species of spider. They do not spin webs but actively hunt their prey, employing a number of senses of which sight is the most important. While many spiders rely mainly on their sense of touch and tend to be nocturnal, jumping spiders are usually at their most active in bright sunshine.

The arrangement of a jumping spider's eight eyes gives it almost 360° vision. The small eyes on the top of its head mean that it is immediately aware of a fly, for example, alighting within a distance of about 30cm (12in) from it. The spider turns its cephalothorax, or front part of the body, towards it so that its anterior eyes can focus clearly. It then moves stealthily forward, flattening itself to the surface, until sufficiently close (about 2.5cm/1in away) to leap on to its prey. This ability to focus accurately and assess distance is unique among spiders.

Athletic leapers Of the four pairs of legs the first, particularly in male jumping spiders, is usually the most powerfully built. Although the legs are used to grasp prey, the extra development of this first pair is more likely to be an adaptation for courtship.

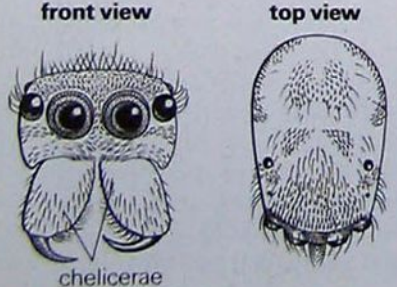
Rather surprisingly, it is the two pairs of hind legs, apparently unmodified, that supply the power for jumping. This is illustrated by the fact that if one or both of the front legs are missing, a spider's jumping ability is not affected. However, if a hind leg is removed, the spider will land badly, in a position some-

Above: A zebra spider (*Salticus scenicus*) eating an aphid. A jumping spider does not trap its prey in a web. It has an efficient arrangement of eyes and so does not need to rely on vibrations alone to detect the presence of prey. When it jumps on its victim, the spider holds its front pair of legs straight out and grasps the prey with them. In summer, zebra spiders are seen on garden walls and fences. They have an alarming habit of apparently staring back if watched!

Above: *Marpissa muscosa*, showing the small eyes on top of the cephalothorax which can distinguish prey approaching from behind. Its coloration acts as camouflage and makes it less obvious to its unsuspecting prey.

Jumping spider vision

The eight eyes on the head (cephalothorax) of the jumping spider are arranged in three rows. The four large eyes of the front row resemble the headlamps and sidelights of a car. The two pairs of smaller eyes form a quadrangle, facing upwards and backwards, on top of the head. This battery of eyes gives almost 360° vision.



what askew of its takeoff. It is the sudden extension of the legs by increased fluid pressure that enables the spider to jump; ordinary muscle action in the legs is used only for retraction.

Jumping spiders leap from stem to stem with great ease and are saved from falling by the silken threads or draglines they lay down wherever they go. They have even been seen to leap away from a building and catch insects in flight, a feat that demonstrates the remarkable co-ordination of their senses. When it is necessary to jump gaps or escape capture, their light weight allows them to make great leaps of up to 40 times their body length. Vertical, overhanging or smooth surfaces present no difficulty as the adhesion of their foot pads is greater than in any other family of spiders. Many species can move almost as quickly backwards as forwards.

Sun-loving species The distribution of jumping spiders in this country reflects their need for sunshine and warmth (they abound in the tropics where the heat encourages larger and more athletic species). While 28 species have been found in Dorset and Hampshire, only 11 species have been recorded from Scotland, where they are usually scarce. In the islands of Orkney and Shetland, only one species, *Neon reticulatus*, has been discovered.

For protection from the elements, many species seal themselves into silken retreats under stones or loose bark, or inside rolled leaves. In these cells they pass the night, shelter from cold or wet conditions, moult their exoskeletons and rear their young.

Most species lay their eggs in early summer, after which the males die, while the females live until mid-summer. When the eggs have hatched, the young grow rapidly until the onset of cold weather. They hibernate through the winter and finally become mature in the following spring.

Where to look for jumping spiders Our best-known species of jumping spider is the black and white zebra spider, which is common in early summer on walls and garden fences. It walks in a series of jerks, and if you watch it closely it will often turn and stare back with a similar intentness. Measuring about 7mm ($\frac{1}{4}$in) long, the sexes are distinct in appearance and the male can be distinguished by its huge, unwieldy fangs (chelicerae). These are used to restrain mates and other males, rather than for purely aggressive purposes.

The two species that appear to be most common in the countryside belong to the genus *Heliophanus*. *H. cupreus* and *H. flavipes* both measure about 6mm ($\frac{1}{4}$in) long and are basically greenish-black in colour, but with differing amounts of yellow on their legs and palps. They are found among grasses and shrubs in a wide variety of habitats, including grassland, woodland and wasteland.

The two largest species, measuring up to 10mm ($\frac{2}{5}$in) in length, are less widespread in

Left: Male jumping spiders use their bright yellow palps (sense organs near the mouth) in visual displays. These also involve the body and legs and are important in courtship when the decorative patterns, which are a feature of the group, are displayed to greatest effect. This species is *Heliophanus cupreus*, one of the most common in the countryside, appearing in a variety of habitats from woodland to wasteland.

Spiders mating

When the male *Euophrys frontalis* meets the female, courtship begins when he shoots his front legs straight up in the air. He raises himself up on his other legs, then lowers the front legs until they touch the ground, whereupon they are snapped up again vertically. This is repeated many times, and each time he moves one step nearer. He vibrates his yellow palps in front of his face and his eyes, set among black hairs and rusty red down, seem to flicker hypnotically. If accepted by the female, the suitor reaches over her cephalothorax to insert the genital organ on his palp into the genital opening (epigyne) on her underside.

normal position courtship display

Above: A small male (on top) mates with a female *Evarcha falcata*.

distribution. *Marpissa muscosa*, although uncommon, may be numerous locally. One place to look for it is in the hop fields of Kent, where it has colonized the flaking hop poles. Its flattened form and grey and brown coloration, with a pattern of chevrons on the abdomen, enable it to blend with the background of weather-beaten wood. It is also found in the crevices of old stone walls or beneath the loose bark of trees. *M. radiata*, also strikingly patterned, is common in a number of fens in East Anglia, where it constructs its retreat among the flowerheads of the reed *Phragmites*.

Specialised jumpers Some jumping spiders are specialists, living in a particular restricted habitat or niche where they may be quite numerous, although rare in national terms.

Ballus depressus, for example, is a squat, reddish-brown jumper confined to the foliage of oak trees in sheltered positions, where it is usually present in large numbers. The male can be recognised by his swollen, black and yellow front legs.

Euophrys lanigera is probably an immigrant from the Mediterranean region and spends its life on the roofs of houses in southern England. It is a small species, measuring only 4mm in length, and appears to be expanding its range and increasing in numbers. A close relative of this species is *Euophrys frontalis* which is native to Britain and quite common in various types of low herbage. The females are pale and spotted, while the males are darker with black and cream front legs.

One species, *Myrmarachne formicaria*, is often found in association with ants, running among swarms of them. This seems to give it increased protection from predators, something that is aided by its coloration, which mimics its ant associates. It has a slender brown body, with constrictions in the cephalothorax and abdomen, and slim legs. It even moves in a very similar fashion to the ants that it runs among. *M. formicaria* is a very rare species, being found only in the south and then only in a handful of localities.

Myrmarachne formicaria. Female. Length to 7mm ($\frac{1}{4}$in).

Heliophanus flavipes. Female Length to 6mm ($\frac{1}{4}$in).

Marpissa radiata. Female. Length to 10mm ($\frac{2}{5}$in).

Careful disturbance of suitable vegetation such as heather may reveal one of the two species of *Evarcha* leaping from plant to plant. *Evarcha arcuata*, shown right peeping out of its white silk nest suspended among the sprigs of bell-heather, lives in the southern heathlands. It reaches a length of 7mm ($\frac{1}{4}$in) and the male is dark and elegant, while the female has a pale abdomen with an attractive pattern of chevrons. The second species, *Evarcha falcata*, is more widely distributed, occurring among shrubs in heaths and woodland throughout the country.

STREAMS THAT RISE FROM CHALK

Although they are often thought of as natural and untouched, chalk streams are the product of deforestation, farming, water supplies, weed cutting and artificial stocking with fish – and they are, in consequence, very different from their original state.

Below: The River Itchen (Hampshire) in June, with masses of water-crowfoot growing up to the surface. On some chalk streams these and other weeds are cut twice yearly to prevent flooding and make angling easier.

The soft, calcareous, porous rock known as chalk only occurs in England, France and New Zealand. In England it is found in hills (downs) and plains within a crescent extending from Dorset, through Kent and Hertfordshire to Norfolk and North Humberside. The smaller rivers rising from this rock are known as chalk streams. As a result of a rather special combination of climate, geology and human activity, they have several characteristic features which encourage plant and animal life and make them unique.

Natural characteristics Most of the water of chalk streams comes from rainfall which has percolated slowly through the overlying soil and accumulates in the chalk. Hence it is stable in temperature, clear, and rich in calcium, nitrates and carbon dioxide. Also, downstream of the permanent springs, variations in flow are small.

Further up the valleys are water-courses, known as winterbournes, which flow only in the winter and spring when the water levels in the chalk are at their highest. The valleys

are neither particularly steep nor particularly flat, so the water flow is moderately fast. This fast flow helps to keep the water well aerated, prevents the accumulation of large areas of silt, brings a continual supply of mineral nutrients and organic food to the plants and animals of the river and rarely causes them damage.

Man's activities The features described above have always been the natural characteristics of chalk streams, but many others have arisen from man's activities. The early history of the lower valleys of the River Frome in Dorset, for instance, is known from pollen and other remains preserved in peat which has accumulated in permanent reed swamps since the end of the Ice Age.

For nearly 10,000 years after the Ice Age the valleys were thickly wooded, with pine and later oak on the sides and alder or willow in the flood plains. The rivers are likely to have flowed in several small channels in deep shade through these forests. Water plants would have been few and most animal food would have come from tree leaves. Many of the animals common now, which depend on water plants for food, support and shelter, would have been scarce then. For example, the grannom fly and many of the reed smuts or blackflies would not have been abundant.

Forest clearance was started around 1000 BC and many of the valley bottoms were cleared by Roman times, which encouraged the growth of water plants. The Romans and Saxons started building water mills, small at first but later much larger. In the basin of the River Frome there were over 50 such mills. Each had a weir, a mill-leat and a tail-race (a watercourse to and from a mill), which introduced new types of habitat with either unusually fast or unusually slow water flows. Although very few of these now work, the altered habitats remain. In the slow waters pondweeds began to grow. At first the perfoliate pondweed appeared and later, after its introduction from North America, Canadian pondweed became important. Another species, *Elodea callitrichoides*, has recently been introduced. Typical animals, not common in the normal streams, now include the water skater, the pond olive, many damselflies and roach.

Above: Dense growths of water weeds are typical of chalk streams. In the smaller streams water-cress (shown here), fool's water-cress and lesser water-parsnip are common, while in the larger streams water-crowfoot is usually the dominant species.

Right: In the smaller chalk streams fishes such as the bullhead and the minnow can be found—and they attract the brilliantly plumaged kingfisher, who waits silently on a post for a fish to appear then makes a sudden and dramatic dive to catch it with its long powerful beak.

Below: An old water mill at Longparish on the River Test in Hampshire. Such mills were first built by the Romans, and then by the Saxons. They altered the speed of water flow and consequently the plants that were able to grow in the water. Although very few of the mills work today, the altered habitats remain.

A little later drainage of the fields in the valley bottoms started, reaching a climax between 1650 and 1900 in the elaborate system of water meadows. These took much of the flow into new or deepened and narrowed channels. The damp, grazed meadows became rich in flowers, including several species of marsh orchid, and marsh cinquefoil.

As the populations of the valleys increased, human and animal sewage affected the chalk rivers (nowadays it is mostly discharged as well-treated mineralised effluents), increasing the amount of phosphorus entering the water. Recently agricultural fertilisers have also increased the nitrogen entering the rivers. However, the naturally fertile soils of the chalk streams have probably always provided ample nutrients for plant life. At present over 40 times as much nitrogen, phosphorus and potassium flow past the water plants as they need for their annual growth, so man-made changes in the amounts of these minerals have little effect.

Many of the springs are used as water-cress beds or trout farms, these uses modifying the temperature, mineral and organic content of the water, and on occasions plants or non-native fish (such as the rainbow trout) are released into them.

More and more subterranean water is abstracted from the chalk for man's use,

Above: A brown trout swimming among water-starwort above the gravelly bottom of the River Test. The chalk stream gravel beds, abundance of water weeds and waters flowing at different speeds are well suited to the lifestyle of this fish. Trout, and even salmon, are sometimes artificially introduced into the streams, making the fishing rights extremely valuable.

Above: A mayfly just emerged from its aquatic nymphal stage. The usual brief lifespan of adult mayflies—less than a day—is often even shorter.

which has sometimes decreased the flow. This may lead to a reduction in water-crowfoot and animals such as the mayfly and trout, while increasing silt, silt-loving animals and blanket-weed. However, recent developments put water pumped from the chalk into the streams, so that it flows downstream to the towns requiring it. This is often done in times of low flow, thus improving the river.

Chalk stream plants Dense growths of water weeds are typical of chalk streams. In the smaller streams you can find fool's water-cress, lesser water-parsnip or water-cress while in the larger streams chalk-stream water-crowfoot is usually dominant. These weeds hinder the flow of water and cause spring and summer flooding. To prevent flooding, and to make angling easier, these weeds have been cut once or twice a year for at least 150 years at many sites, probably for much longer. In the past this was done selectively by gangs of men with scythes, but now most Water Authorities use mechanical cutters in the larger channels.

The intensity, manner and frequency of weed cutting greatly influences water life. Water-crowfoot, in particular, appears to thrive on the normal pattern and it would change its abundance if cutting was altered. If cutting is stopped, the amount of weeds present in the summer decreases in the following years. An unusually heavy and late cut has been shown to decrease water-starwort and increase water-crowfoot in the next year.

Some fish, such as roach, spawn on bank-side weeds near the surface about the same time as the first weed cut. A fall in water level following an early cut could kill many of their eggs. Mortalities of young fish are higher in cut reaches of rivers, and in small streams herons can soon catch all the trout when there is little weed left. Water-cress has very dense populations of water-shrimps and non-biting midges, which are reduced or lost when the plant is absent.

In the winterbournes there are plant species which can tolerate dry periods because they have aerial leaves and deep roots, and which thrive in the absence of management. Fool's water-cress is one example.

Thriving fish Chalk streams are particularly suitable for trout. There are gravel beds for spawning and weed beds and a variety of currents to provide cover, territories and a plentiful supply of food. The stable water temperatures provide trout with the cool water they need in summer and the warmer spring and autumn temperatures allow early hatching and a high growth rate. The fishing rights are very valuable, especially when salmon are present, and many of the fish populations are managed. When anglers control the management, weed cuts are made to encourage fish food such as water-shrimps and flies and their nymphs. Gravel beds for spawning are encouraged in many streams.

Coarse fish, especially grayling and the predatory pike are discouraged or removed (50,000 a year in some places). Nevertheless, other fish often remain biologically more important and productive. In the smaller streams these are the bullhead and the minnow and, in larger streams, eels and dace.

The chalk streams of England

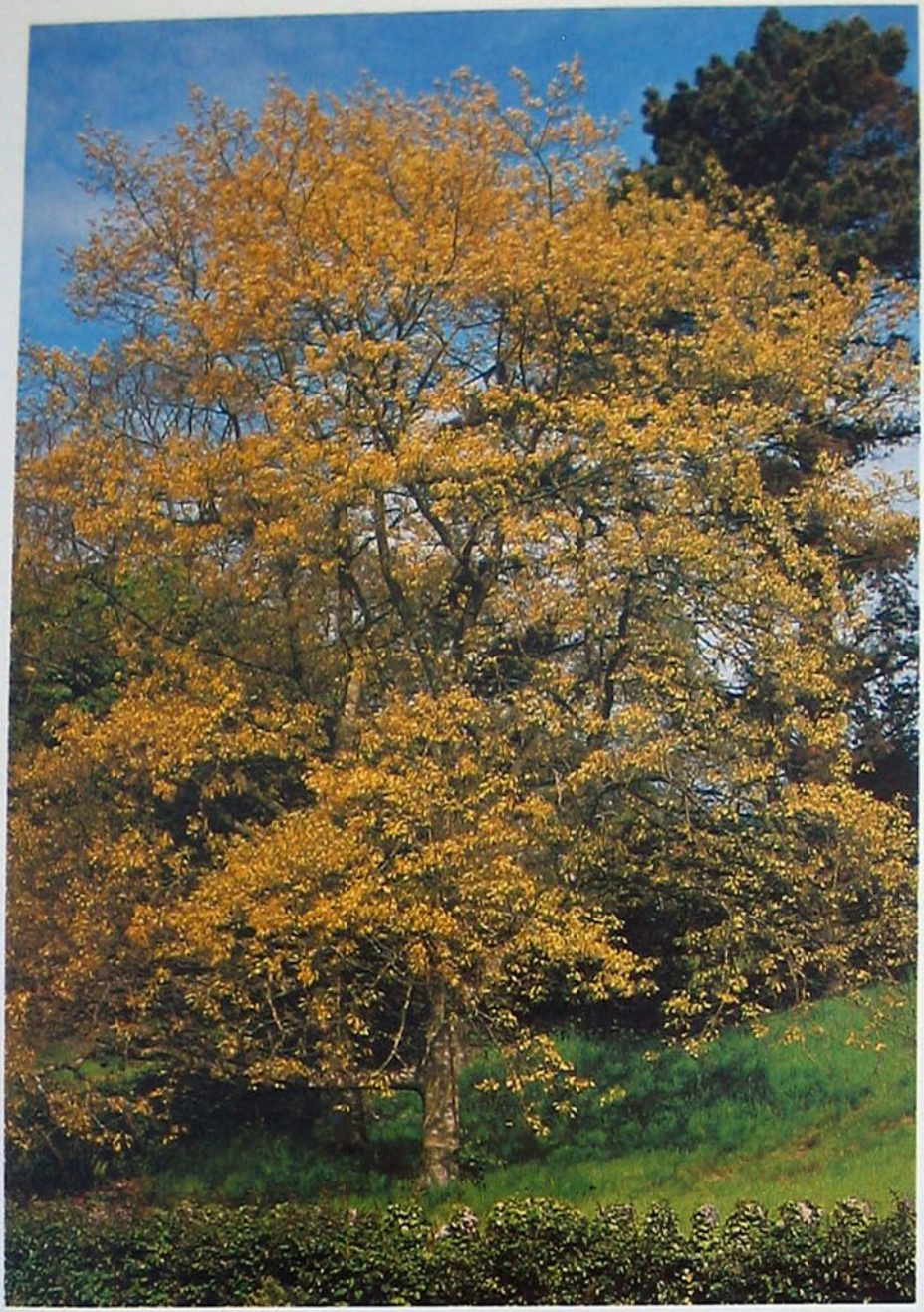
1 River Hull (upper reaches above Beverley)
2 River Bain
3 River Nar
4 River Lea (above Chingford)
5 River Chess
6 River Lambourn
7 River Kennet
8 River Itchen
9 River Test
10 River Avon (Wiltshire)
11 River Wylye
12 River Frome
13 River Allen
14 River Great Stour
The lower reaches of these rivers may not have all chalk stream features. The rivers Witham, Great Ouse and Thames connect the chalk streams that flow into them but are not chalk streams themselves. (These are marked on the map with a dotted line.)

COLOURFUL OAKS FROM AMERICA

The red oaks are a group of New World oaks often seen growing in British parks and gardens. These trees are notable for their superb display of autumn colours, as shown here in the tree after which the group is named–the red oak itself.

The oak has for long been considered the national tree of England yet, of the approximately 450 species of oak to be found throughout the world, only two are native to this country. These are, of course, the English oak and sessile oak. Yet there is a great number of oaks native to the New World, being found in either North America, Mexico or Central America.

Being such a large and variable genus, the oaks are grouped by botanists into various catagories called sections. Most oaks seen in Britain, including our native oaks, belong to the section Quercus, or white oaks. This is the only section with representatives in both the Old and the New Worlds. Among the New



World oaks, however, especially those planted in Britain, most belong to a separate section, called Erythrobalanus, or red oaks.

Red and white oaks The red oak section differs from the white oaks in several respects. The acorns take two years instead of one to ripen, the inner surface of the acorn shell is hairy or downy instead of being hairless (though some white oaks have slightly hairy inner surfaces), and the bark is much smoother, particularly on young trees. The two groups also differ in the shape of the flower: on white oaks the style is very short or even absent, whereas on red oaks it is elongated.

There are important differences between the two groups in the shape of the leaves, though this is not a reliable guide to telling them apart. In general, however, red oaks have sharply pointed lobes ending in a fine filament – a continuation of the veins. White oaks, on the other hand, have rounded lobes – to us, the typical oak-leaf shape. Both groups include members with prickly leaves, such as the holly oak, and red oaks even include trees with willow-like leaves, having only a terminal filament.

Red leaves in autumn One of the most important members of the red oak section, and the most commonly planted in this country, is the red oak itself. The name refers primarily to the colour of its leaves in autumn (a feature shared with many other trees in the red oak section), though its inner bark and its young winter shoots are both also red. The red colour of the inner bark is not a feature that can often be checked, though the occasional wind-damaged branch may show it. In this case it can be seen that the dead outer layer of bark is dark grey-brown, but beneath this is a soft living layer of pale red bark.

The red oak is native to the eastern half of North America, extending from southern Canada and Nova Scotia down to Georgia and Louisiana in the south. It was introduced into Britain early in the 18th century and has since become the most popular of the American oaks in this country, being widely planted in parks and public gardens for its ornamental value.

Broad domed crown The red oak forms a tall tree, in Britain growing to a height of 30m (100ft), with a broad domed crown on top of a short stout trunk. The grey-brown bark is often broken into small plates on mature trees, but on young trees it is smooth and silvery grey.

The leaves of a red oak are highly variable. Their size may range from 12-22cm (5-9in) long by 10-15cm (4-6in) wide, the number of lobes may vary between seven and twelve, and the depth of these lobes may be between half and quarter of the distance between the leaf-margin and the midrib. The number of bristly filaments on each lobe also varies: there is

Above: When they first emerge, the leaves of a red oak are bright yellow. This colour can persist for up to a few weeks before they darken to their summer matt green.
Notice how this tree exemplifies the typical shape of a red oak: a broad domed crown with strongly ascending branches on top of a short trunk.

Right: A red oak just about to flower. The male flowers are borne in catkins (not yet open here), while the female flowers resemble small tufts and sit in the leaf axils. The flowers appear in May, just after the leaves have unfurled.

Above: **Pin oak** (*Quercus palustris*); leaves deeply lobed, 8-15cm (2½-5in) long. Height 25m (80ft).

Below: **Red oak** (*Quercus rubra*); leaves variably lobed, 12-22cm (5-9in) long. Height 30m (100ft).

Above: **Willow oak** (*Quercus phellos*); leaves lance-shaped, 5-13cm (2-5in) long. Height 25m (80ft).

Below: **Scarlet oak** (*Quercus coccinea*); leaves deeply lobed, 8-18cm (2½-7in) long. To 25m (80ft)

always one at the tip of each lobe but there may be one or more on the sides.

One of the red oak's most spectacular features is the colour of its leaves. When these first open in spring they are a bright yellow and stay this colour for several days, or even weeks. Then they become a dull matt green until late in the year, when they turn a variety of colours, from a deep red to yellow or russet-brown.

Flowers and fruits In May, the male and female flowers appear. In typical oak fashion the male flowers appear as slender yellow catkins, whereas the female flowers are extremely tiny and insignificant.

The flowers are followed by acorns. At the end of the first year these are still small and squat, but by the time they have ripened a year later the acorns have become elongated and are borne in shallow cups.

Fast-growing shoots The red oak is one of our fastest-growing trees, with shoots up to 2.5m (8ft) long appearing in a single year. In North America, this quality makes the tree a useful source of timber but, so far, it has not been widely planted in Britain for this purpose.

The Forestry Commission have planted some red oaks around the edges of their conifer plantations to act as a screen and provide some diversity. Like our native oaks, the red oak does not cast too dense a shade, so allowing other plants to grow beneath. Thus they provide an attractive border to what is typically an otherwise rather monotonous conifer wood.

Less familiar red oaks Several other members of the red oak section have been introduced to Britain, though on a smaller scale than the red oak itself. Perhaps the most attractive of these is the scarlet oak. This tree is similar in many ways to the red oak, but can be distinguished at a distance by its smaller stature (up to 25m/80ft tall) and its longer, more slender trunk.

Its name comes from the fact that its leaves turn a much more pronounced red in the autumn than those of the red oak. Usually the autumn colour appears first on just one or two limbs of the tree, with the rest of the tree remaining green–among red oaks, a feature unique to this species.

The leaves of the scarlet oak are smaller than those of the red oak, with five to nine more deeply cut lobes.

The pin oak This species is similar in most ways to the scarlet oak, though it is quite different from a distance because the lower branches droop down to form a characteristic skirt. The upper branches, however, are swept strongly upwards. The leaves have the same size, shape and colour as those of the scarlet oak, except that the lobes are cut a little deeper.

The willow oak This species of red oak is quite different from the others because its leaves are unlobed. Instead, they are long and slender and resemble willow leaves. They still have the deep red autumn colour so typical of this group, however. Although the willow oak is today one of the rarer red oaks to be seen in Britain, it was the first member of this group to be introduced here, at the beginning of the 18th century.

Above: The acorns and leaves of our most common New World oaks, showing their autumn colours. All have the lobes of their leaves (if present) sharply pointed and ending in fine filaments. The acorns take two years to mature. Here, the mature acorns are shown detached, with this season's acorns still on the twigs.

Below: Bright red autumn colours are a common feature of trees in the red oak section, though in practice the colours can vary from scarlet or crimson to yellow or brown. The leaves shown here are from a pin oak.

THE DISPERSAL OF THE RED FOX

As a family of fox cubs grows up, the links between them diminish. They soon start to travel alone in search of food, and by winter all young dog foxes have left home, some of them on long journeys of up to seven miles from their birthplace.

Above: A fox cub assessing his surroundings and (opposite right) a more mature red fox on his travels. When foxes are making excursions from their birthplace they may exhibit an extraordinary sense of direction. In studies in Oxfordshire, juvenile foxes have been radio-tagged and followed into countryside apparently unknown to them; then they have suddenly turned to head unerringly for home.

The social organisation of red foxes is varied and flexible, and local differences are probably a consequence of varied food supplies, and different levels of mortality, much of it at the hand of man.

Irrespective of the adult group size in early spring (probably a single dog fox and between one and four adult vixens), it is swollen in summer by the annual addition of cubs. By late summer and early autumn, as these cubs mature, a new set of social pressures arises within the fox community. The home range that previously supported a couple of foxes must now sustain two or three times that number.

Growing up As a family of cubs grow up, the links between them diminish, and the extent to which their activities are concentrated around the earth also declines. Cubs are born in late March, and by the end of July they are already travelling throughout their parent's range. Initially it is not uncommon to see a single youngster trotting at an adult's side, sniffing to investigate everything that catches the adult's attention. Later in summer cubs travel alone, sometimes returning to lie up near the earth, but sometimes focusing their movements on small ranges within the parental territory. As summer draws into autumn you may see small parties of foxes lazing together in the warming rays of the dawn sun. These will probably be sisters which grew up together and may remain in the group throughout the winter, and perhaps for years. However, for some young vixens, and almost all young dog foxes, the autumn of their first year sees the break-up of family ties and the start of their dispersal.

Leaving home Nobody knows exactly what prompts young foxes to leave home, but they can disperse over enormous distances, with males generally travelling further from their birthplace than females.

Once a fox leaves its home range it may behave in a variety of different ways. Sometimes a young dog fox weaves its way across the countryside, travelling far in one night, then spends a few days in one area before

moving on. In this way he may criss-cross the locality, perhaps even ending up again, even temporarily, back where he started.

Other young foxes that have been radio-tracked have moved in a much more determined fashion: striking out from home in remarkably straight lines and being deflected only by major obstructions such as towns or rivers. Yet others seem to edge cautiously into dispersal; they make excursions from their natal range either in a variety of directions or to the same place. Then after several days or weeks of these short excursions they may move to the new site that they seem to have been prospecting.

Approach of winter With the end of autumn some mature foxes may also make excursions out of their previous territories. Dog foxes may go in pursuit of vixens on heat, while throughout the year even resident foxes will occasionally make excursions in search of extra food. Young dog foxes always disperse during their first winter. Popular opinion asserts that this is because their fathers drive them out, but of the radio-tagged foxes that have been studied, there is only fragmentary evidence that their departure was precipitated by an attack from the father. The timing of the departure is probably influenced by a combination of mounting pressures, ranging from parental aggression to diminishing food supplies in early winter.

The problem of securing adequate food in the cold months is not just a problem for juvenile foxes before they have perfected their hunting techniques; it is perhaps especially acute for animals which, like the fox, are opportunistic in their lifestyle. They hunt whatever is around but, as their prey species are finely adapted to avoid their predators, on some nights a fox may fail to catch anything. A string of such nights can add up to starvation, so foxes have evolved behaviour to minimise this risk.

Many people think of foxes as pure predators, but almost all investigations into the fox diet have revealed that, in addition to various live prey which may even include the sleek and elusive hare (right), foxes eat carrion and fruit. In particular, studies around Oxfordshire show that they eat large quantities of blackberries, supplemented with apples, strawberries and rose hips. It is tempting to believe that the adolescence of growing foxes is made easier by this temporary abundance of fruit, when they are at an age when their hunting skills have had little time to develop, but they relish fruit and sweet things in general. They also search for invertebrates (above), such as beetles.

Fox larders Foxes try to acquire surplus food while the going is good, and they store it for future use. Since much of the fox's food is highly perishable it can only be stored for a short time, but in an opportunistic life this temporary insurance policy may make all the difference.

Foxes dig a small grave, into which the food is carefully nosed. With delicate sweeping strokes of its snout the fox then covers the hoard, pushing down the soil with jabs of its nose. Sometimes it uses its snout to push displaced grass stalks back into position and so further conceal the cache. They have a precise memory for where they have made their caches.

This behaviour probably underlies the phenomenon of foxes killing more than their immediate requirements. They are 'programmed' to seize whatever surplus arises, and caching ensures that they make the best use of it.

SUMMER SKIPPERS

Skipper butterflies, with their moth-like muscular bodies, differ in appearance from other butterflies. Their distinctive, rapid, darting flight gave them their name.

Skippers belong to the Hesperiidae family and in their wing and body structure are very distinct from 'true' butterflies. Like most butterflies they fly by day and have antennae thickened or clubbed at the tip, but they can be distinguished by their quick, darting flight and thick muscular bodies.

The head is wide with the antennae bases well separated, and the antennal club usually ends in a sharp point. The caterpillar, which is usually green or brown, lives in a cell of silk and folded leaves, tapering slightly at each end. Like many moth caterpillars, it pupates in a silken web or cocoon. The pupae of almost all other butterflies are naked, silk being used only to suspend them.

Distribution Eight species of skipper are found in the British Isles. Five are fairly common, though even these tend to have a southerly distribution. The other three are very localised and rare. None of the species produces more than one generation a year, but the life-history of each varies.

The distribution pattern of the skippers is interesting. Only the dingy skipper has ever progressed as far as Ireland, but it is most common in the south of England and Wales. Six of the others have ranges that extend from southern England northward in varying degrees. The large skipper reaches southern Scotland, while the small and grizzled species are found all along the south coast to the

Above: Although not apparent in this pair of mating large skippers, the male is easily distinguished from the female by the dark-coloured 'sex-brand' on its forewing, which it uses during the courting ritual.

Below: The grizzled skipper (*Pyrgus malvae*) is quite similar in character to the dingy skipper. At night both adopt the folded-wing resting position more commonly associated with moths.

northern Midlands. The Essex is predominantly a south-eastern species, thinning out rapidly to the west and north; and the silver-spotted species is confined to the chalk of southern England.

The Lulworth skipper is the most localised of all British butterflies, restricted as it is to a small area on the south coast. The distribution of the chequered skipper is something of a puzzle. It was probably once widespread in Britain, but encountered climatic conditions which drastically reduced its population in all but two widely separated regions. Unhappily, it is now extinct in one of these, probably due to the destruction of its habitat.

Dingy skipper As its name suggests, this is a rather drab little butterfly, but it is one of the commonest species. In all but one of its habitats it appears in its 'ordinary' form, but in the Burren of Clare in Ireland, a limestone district, the dingy skipper has rather different characteristics. It develops handsome markings of dark brown and pale grey, which are far from 'dingy' in any descriptive sense. These butterflies are recognised as a distinct sub-species under the name *baynesi*.

In England the dingy skipper is common in the south, becoming less so further north, and is known in Scotland in only a few localities. It flies during the sunny days of May and June, in dull weather resting on dry seed-heads or grass and looking more like a moth than a butterfly.

The males of this and the grizzled species have special scales–called androconia–in a fold on the front edge of their forewings. These scales are scented and are scattered during courtship and mating to stimulate and arouse the female. The caterpillar is fully grown in August and feeds on bird's-foot trefoil. It spins a cocoon in which it hibernates, pupating the following April.

Grizzled skipper This is the smallest of the family and is easily recognised by its even black and white checks. It flies in May and June and is commonly found on chalk downs and in open woodland as far north as Lincolnshire. The caterpillar feeds on various small plants, such as wild strawberry and cinquefoil, and it overwinters as a pupa.

Large skipper This butterfly is found all over England and Wales and in Scotland to just north of the Solway Firth. As with the small and Essex species, the sexes of the large skipper butterflies are easily distinguished by an oblique black streak of androconial scales on the forewing of the male–often referred to as the 'sex-brand'. These scales serve the same function in mating as those on the dingy skipper, although in that species they are carried on a different part of the wing.

The large skipper flies from June to early July and is common in all kinds of grassy places, both in woods and in open country. In common with the caterpillars of the small and Essex skippers, as well as those of the three rare species, the caterpillar of the large

Above: The dingy skipper is the only one that occurs in Ireland. This is probably due to the fact that this island was cut off from the mainland by the sea long before south-east England was separated from the European Continent. After the retreat of the glacial ice-sheets, animals spread from the south into the land that is now Britain. The hardiest of these (the dingy skipper included) came earliest and were able to cross into Ireland.

Left: A small skipper rests on a muskthistle, a flower to which, along with burdock and knapweed, it is particularly attracted. The caterpillar, however, develops on soft grasses (like timothy and cat's tail) which it uses as its foodplant. It draws grass blades together and spins a silken cocoon to form a pupal shelter.

Large skipper
(Ochlodes venata)

Dingy skipper
(Erynnis tages)

Small skipper
(Thymelicus sylvestris)

Above: The Essex skipper (*Thymelicus lineola*), was not recognised as British until 1890. It closely resembles the small skipper, but their life histories differ greatly. The Essex skipper's eggs do not hatch in winter, although the caterpillar inside is fully formed. It emerges in spring and feeds throughout May, before pupating in June. The butterfly can be seen in July, a few weeks after the first small skippers appear.

skipper feeds on grasses, seeming to prefer cock's foot and slender false brome grass. It hibernates as a half-grown caterpillar.

Small skipper Very common in southern and central England, this butterfly can be found as far north as North Yorkshire in the east but only to northern Wales in the west. Generally it is tawny yellow, but straw-coloured to almost white specimens are seen occasionally. In 1978 a remarkable blue small skipper was seen and photographed near Selborne in Hampshire. The clubs of the antennae are black above and orange-yellow below–an important feature in distinguishing this species from the Essex skipper.

The small skipper flies from the end of June to early August. It prefers damp places, although it can be found wherever long grass is growing within its range. The caterpillar hatches in August, makes a meal of its own egg-shell and then spins a cocoon in which it passes the next eight months of its life without moving. The following April it emerges and feeds on Yorkshire fog and other soft-leaved grasses until it pupates in June.

Essex skipper This is one of the most recent resident species of butterfly to be added to the British list–the delay in detection being due to its very close resemblance to the small skipper. It was not realised that both species existed in Britain until 1890 when specimens from Essex were recognised. The most obvious feature separating the two is the colour of the antennal clubs–black in the Essex and orange underneath in the small skipper.

However, this butterfly is by no means confined to Essex. It is most common in south-east England but has been recorded in a few localities in the south-west–Lincolnshire marks its northern limit. It seems to prefer grassy places near the coast, although it is found inland as well.

Its life-history is different from that of the small skipper; the eggs are laid on grass stems and the caterpillar overwinters within the egg. It emerges to feed in April, pupates in June and is usually on the wing in July. Although it appears later than the small skipper, the two are often seen flying together.

Three rare skippers

Silver-spotted skipper Resembling the large skipper on its upper side, but with a dark green underside spotted with silvery white, this species is now restricted to a few localities in the Chiltern Hills and North Downs. Its decline is due partly to extensive cultivation of the downs, and to the decrease in grazing by sheep and rabbits, which has led to the grassy meadows becoming overgrown with bush scrub. It flies in August.

Lulworth skipper Even rarer, this species is confined to one area on the Dorset and Devonshire coast. The male resembles that of the small and Essex skippers but is darker and duller in colour. The female is marked with unmistakable pale yellowish spots on the forewing. It flies above the sea cliffs in July and August.

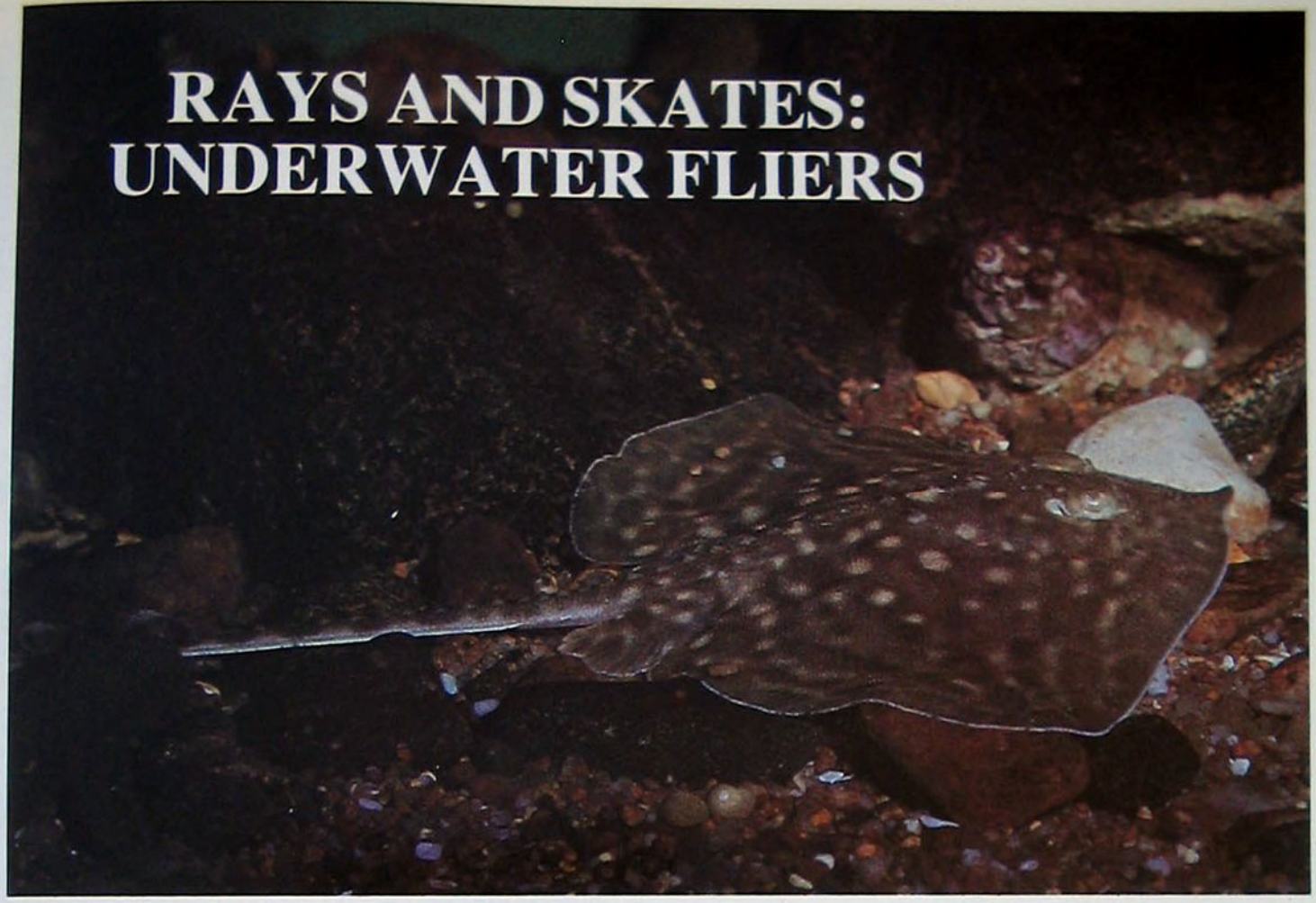
Chequered skipper The rarest British skipper (shown right) and very distinctive–both sexes are blackish spotted with yellow. Believed to be extinct in 1942, it was discovered unexpectedly in western Inverness-shire–now its only British habitat. It is on the wing from May until the end of June.

Silver-spotted skipper
(Hesperia comma)

Lulworth skipper
(Thymelicus acteon)

Chequered skipper
(Carterocephalus palaemon)

RAYS AND SKATES: UNDERWATER FLIERS



Above: A roker gliding along on the sea-bed. All rays have prickly backs to some degree, often with large spines running down the middle, but the roker is covered with particularly large, viciously hooked spines; it should be handled only with gloves on.

Below: The underside of a typical male ray, showing the position of the claspers. In other respects, both sexes exhibit the same features, though the females tend to be larger.

In the popular imagination, rays and skates seem oddly alien creatures. Indeed, they are quite remote from other fishes, their only close relatives being sharks.

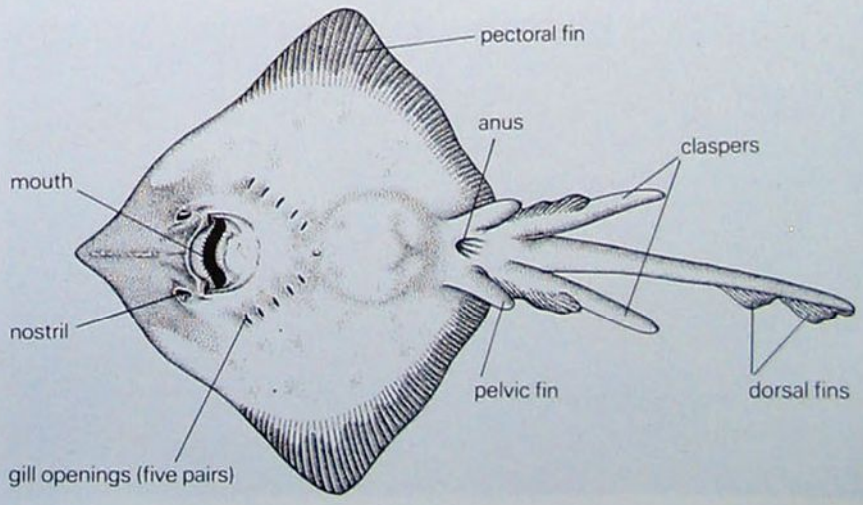
The most obvious feature shared by rays, skates and sharks setting them apart from other fishes is that they have tough leathery skins rather than scales. But the similarities go deeper than that, for both groups are cartilaginous fishes with pliable cartilage skeletons instead of bone. The rays and skates form a distinct group from the sharks, distinguished by their flattened shape, huge 'wings' and whip-like tail.

Ray or skate? In popular usage, the word 'ray' refers to small short-nosed species, whereas 'skate' refers to larger species with elongated snouts. The marine biologist, however, usually refers to them all as 'rays' since there is no clear biological distinction between the two groups.

Most of the species found in British waters, and all those sold in fishmongers as skate, belong to the family Rajidae. The most common British species in this family are the thornback ray or roker, the blonde ray and the spotted ray. The last two are very similar to each other and fetch a higher price in fishmongers than the thornback, which, as its name indicates, has a ferociously spiny back to deter predators. All rays have fine prickles on their skins, but on the thornback they are developed into large, viciously hooked spines, so that the fish can be handled safely only with gloves.

The largest species of ray found around Britain is the blue or common skate – a 2.7m (9ft) specimen was caught in Caernarvon Bay in 1960. Sadly, despite its name, this species is now extremely rare.

Sting rays and electric rays Two other families of rays are represented in British waters, apart from the family Rajidae: sting rays and electric rays. The sting ray has a large

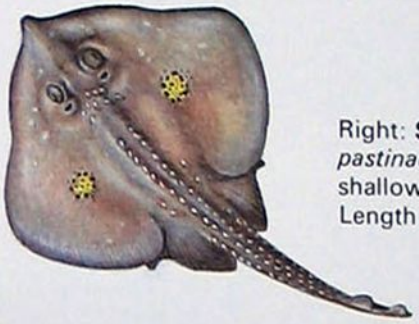


Above: A spotted ray being landed. The technique used, in which the fish is hauled ashore or on-board ship with a long hook, is called gaffing. This species is a relatively common British ray but is not often caught by anglers since it lives well out to sea.

Below: All rays have a hole set just behind each eye on the upper surface of their bodies. This hole is called a spiracle and allows the ray to breathe while resting on the sea-bed.

Right: **Blonde ray** (*Raja brachyura*). Lives on sandy sea-beds to a depth of 100m (330ft). Length 110cm (43in).

Above: **Thornback ray** or **roker** (*Raja clavata*). Our most common ray in shallow waters. Length 90cm (35in).



Right: **Sting ray** (*Dasyatis pastinaca*). Found in shallow water and estuaries. Length 1m (39in).

Above: **Cuckoo ray** (*Raja naevus*). Our smallest ray at 70cm (28in) long. Its back bears two distinct spots.

stinging spine at the base of the tail. The electric ray can deliver a 220-volt shock, with a peak current of 8 amps enough to power a colour television set! It uses it for defence and to stun prey.

Flat from birth As with more familiar flatfishes such as plaice, the flattened shape of rays is an adaptation allowing them to lie inconspicuously on the sea-bed. Unlike these other species, however, rays are born flat; they do not metamorphose from round-bodied larvae.

The eyes lie on top of the body but the mouth lies flush with the underside, though it can be protruded for feeding. The diet of most rays consists mainly of bottom-living animals such as crabs, sandeels and small flatfishes, which they detect by means of a well-developed sense of smell. They can also catch midwater species such as sprats by enveloping them in their wings. All rays, as well as the electric ray, can give out an electric shock (usually weak), which they may use to help disturb or stun their prey. They then pounce on the food with a short burst of speed.

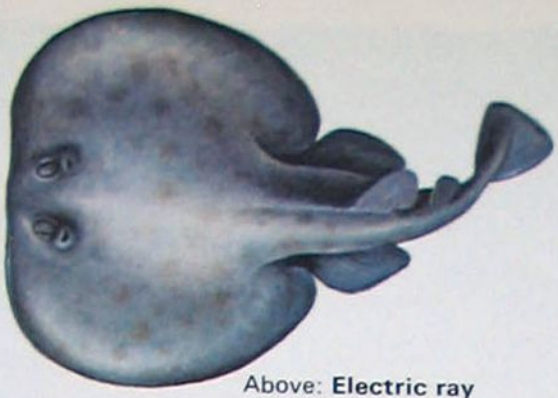
Rays are among the most graceful swimmers of any fishes, moving by a continuous series of undulations passed backwards along their pectoral fins.

Clasping males The reproductive cycle of rays differs in many ways from that of bony fishes. The males are born with a pair of claspers unique to rays and sharks. These are situated at the base of the tail and grow as the ray matures, so that in older specimens they can be half the length of the tail.

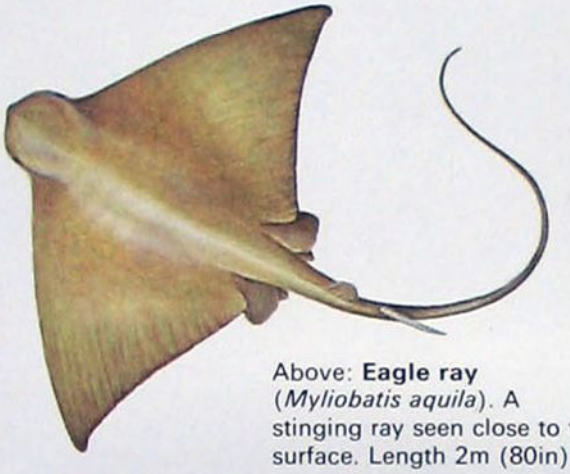
During mating the claspers are brought together to form a channel through which the sperm is introduced into the female. Meanwhile, the two fishes are held together by hooks on the male's claspers and, in some species, on the wings as well.

Eggs in purses Most bony fishes lay a great number of tiny eggs, but the rays (and most other cartilaginous fishes) produce a much smaller number of large eggs. Each egg of a ray is contained inside a tough protective envelope – the familiar mermaid's purse – for an incubation period of anything between

Left: **Spotted ray** (*Raja montagui*). Lives on sandy bottoms in deep water. Length 75cm (30in).



Above: **Electric ray** (*Torpedo nobiliana*). Differs from other rays in its smooth skin. Length 1.8m (70in).



Above: **Eagle ray** (*Myliobatis aquila*). A stinging ray seen close to the surface. Length 2m (80in).

Declining numbers Over the last 80 years, the pressure of fishing has caused stocks of many rays to fall dramatically. The problem is compounded by the fact that young rays are unusually large when they hatch, and so they can be immediately caught in trawls and shrimp nets. The blue skate, for example, is 22cm (9in) long at hatching.

As its alternative name of common skate implies, the blue skate used to be a popular specimen fish for anglers, but it is now among the most threatened of all our rays. Angling organisations have removed it from their lists to encourage anglers to return it to the sea if they catch one. Unfortunately, this is unlikely to stop the decline since most of the blue skates caught nowadays are taken as bycatches in commercial trawling. As yet, there is no method of preventing this from happening.

As an example of the decline of this fish, records for 1902 state that the blue skate was abundant in all parts of the Irish Sea. Today, the annual catch for the whole of the Irish Sea is just one or two fishes.

The story is much the same for other British rays. In 1938 the total catch for all ray and skate species was 17,475 tonnes; in 1980 this figure had fallen more than five-fold to 3136 tonnes. All the signs are that this downward trend will continue. The blue skate in particular may soon disappear from our waters, and with hardly anyone noticing.

four and fifteen months. The egg-cases, usually laid in shallow water, are stuck to stones and shells, but they can often be seen washed up on the shore. They are similar to the mermaid's purses of dogfishes, except that they have a pointed horn at each corner, rather than coiled tendrils.

Egg-laying can take place any time between March and August, and the cases are most commonly seen on the shore in late summer and autumn.

For the first few days after hatching, the young ray lives on the yolk inside the egg. Thereafter, it begins feeding on small bottom-dwelling crustaceans such as shrimps.

Slow to mature Rays take an exceptionally long time to mature. This, plus the fact that they lay far fewer eggs than bony fishes, makes them extremely vulnerable to over-fishing. For example, each herring lays thousands or even millions of eggs in a year and the young fishes reach maturity in two or three years. Compare these figures with those of rays. The roker becomes sexually mature at nine years and lays about 140 eggs a year; the blonde and spotted rays mature at the same age but lay only 70 eggs a year; and the blue skate matures at eleven years and lays just 40 eggs a year.

This reproductive pattern makes rays vulnerable to over-fishing by man – as are some marine mammals, particularly whales and seals.

Right: Rays lay their eggs inside cases known as 'mermaid's purses'. The cases are laid in shallow water stuck on to shells or stones, but they are often washed up on beaches.

Below: Incubation takes between four and fifteen months. For the first few days after hatching, the young ray survives on a yolk-sac attached to itself.

PROLIFIC PARSLEYS

Cow parsley, hemlock and hogweed, often found growing in abundance, can be difficult to tell apart. However, it is much easier to distinguish their rather surprising relative, the spiny sea holly.

The parsley or carrot family, the umbelliferae, contains nearly 3000 species and its representatives are found in most parts of the world. Between 70 and 75 of these species are found in the British Isles; of these nearly two-thirds are native.

Habitat and appearance There are few habitats in the country where umbellifers do not occur. They can be found in woods, in dry grassland, on cliffs or sand dunes, on river banks, in ditches and even in slowly flowing rivers. Many are commonly found growing by the roadside, and a few even grow on refuse tips, or as garden weeds.

The distinctive inflorescences borne by most species are known as umbels, and comprise clusters of tiny flowers which may vary from a few in number to thousands. The individual flowers may be either male or female, or hermaphrodite – the female flowers surrounding the male flowers. In most species, the anthers shed their pollen before the stigma of the same flower is receptive. This means that pollination normally takes place with pollen from a different plant (cross pollination). However, self-pollination can occur if pollen from another of the plant's own flowers falls on a receptive stigma.

Many insect visitors are attracted to umbellifer flowers. Beetles, flies, ants and short-tongued bees are the most common and can be found walking somewhat precariously over the umbels. They may feed on the copious quantities of nectar secreted by the exposed disc at the base of the styles (the stylopodium) or may collect and eat a proportion of the nutritious grains. They may also help in pollination, although more by accident than design.

Above: The delicate white flower heads of cow parsley (*Anthriscus sylvestris*) are found from April to early June along roadsides. After the flowers have died away, the dead, hollow stems remain standing throughout autumn and winter.

Below: The massive flower heads of the giant hogweed (*Heracleum mantegazzianum*) measure up to 50cm (18in).

Familiar umbellifers Two of the most commonly occurring and recognisable umbellifer species in the British Isles are often found growing together but flowering at different times. Cow parsley and hogweed grow on roadsides, shady hedgebanks, in wood margins and in dry, grassy places.

Cow parsley, sometimes known as keck, is one of the early flowering umbellifers. It is widely distributed and extremely abundant, particularly in the south. Like several other members of the family, including carrots and parsnips, this species develops a tap root. It is a biennial, producing a basal rosette of leaves, with the flowers appearing the following year.

Hogweed, sometimes known as cow parsnip, is also a biennial, flowering during most of the summer and early autumn. A robust and coarsely hairy plant, it grows throughout the British Isles. The umbels are large and flat, measuring about 5-15cm (2-6in) in diameter, with white or greenish-white male or hermaphrodite flowers.

Poisonous giant The giant hogweed is a

relative of the British hogweed and was originally introduced to the British Isles as an ornamental from south-west Asia. It soon escaped and is now found in many scattered localities on waste ground, roadsides and near rivers.

It is remarkable for its giant inflorescences and hollow, hairy, purple-spotted stems which reach up to 5.5m (17½ft) in height and 10cm (4in) in diameter, making it one of our largest herbaceous plants. Giant hogweed has a strong smell and it may cause very irritating dermatitis if touched, especially in strong sunlight, and it is now an offence to plant or otherwise grow it in the wild.

Hemlock is another umbellifer to be avoided since it is one of the few members of the family to produce highly poisonous chemicals of the group known as alkaloids. It grows in damp places on roadsides, rubbish tips, river banks or fens, and is more common in southern England. A biennial, it reaches about 2m (6½ft) tall and has relatively small inflorescences. These are composed of hundreds of tiny white flowers which have an unpleasant smell and are either hermaphrodite or male. The fruits are ovoid and possess several conspicuous, longitudinal, wavy and toothed ridges. They are the most poisonous part of the plant.

Woodland and garden species Another species with small inflorescences is sanicle, which grows in woods, particularly beech and oak, throughout the British Isles. The hemispherical inflorescences of white or pinkish flowers measure only 5mm (⅕in) across and appear from May to July.

Ground elder, a woodland plant in most of Europe and Asia, is probably a garden escape which has become naturalised. It has long, slender rhizomes and is an extremely persistent garden weed throughout most of the British Isles.

Unusual relatives Two species which are not quite so typical of the family are sea holly and marsh pennywort. As its name implies, sea holly can be found on sand dunes and also on shingle near the high tide mark, and it is common on most coasts around the British Isles. The flowers, which appear from June to September, are bluish-white and clustered tightly in a flower head which is not typical of the family.

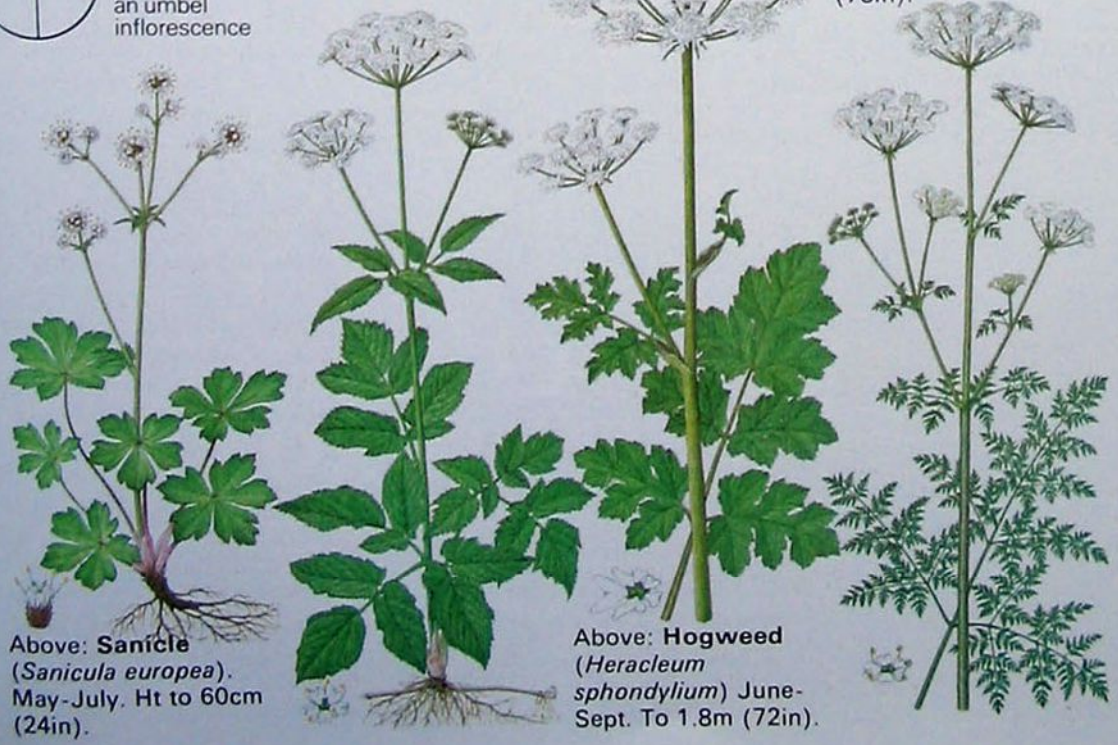
Marsh pennywort, an inhabitant of damp grassland, fens and sphagnum bogs, is unusual in that, unlike most umbellifers, its leaves are not highly dissected but rounded and entire and about the size of a ten pence piece.

Above: Sea holly (*Eryngium maritimum*) is an unusual member of the parsley family. The appearance of its leaves is unique within the family, as they resemble a thistle rather than those of a carrot or parsley. The flower head is also more like a miniature teasel in structure. The spines are extensions of the flower's sepals, and when the fruits appear they are covered in hooked bracts.

an umbel inflorescence

Below: **Ground elder** (*Aegopodium podagraria*). May-July.

Below: **Hemlock** (*Conium maculatum*). June-July. Ht to 2m (78in).



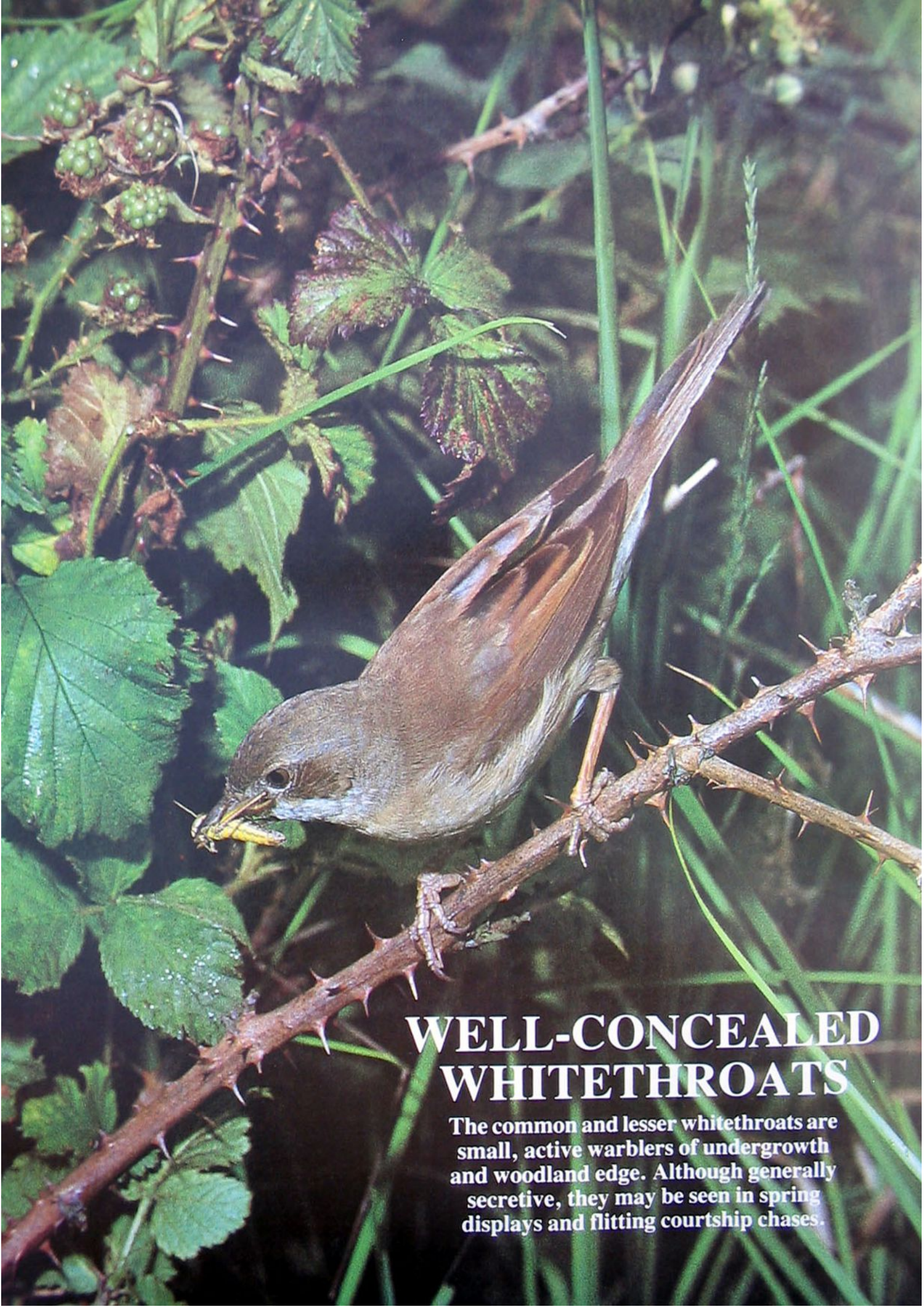
Above: **Sanicle** (*Sanicula europea*). May-July. Ht to 60cm (24in).

Above: **Hogweed** (*Heracleum sphondylium*) June-Sept. To 1.8m (72in).

Useful umbellifers

About a dozen species of the parsley family are used regularly by cooks, either as vegetables or as garnishes and flavourings. The main vegetables are carrots and parsnips, where the roots are eaten, and celery where the stem and petiole provide the food. Soups, sauces, salads, meats, cakes and even liqueurs are flavoured by the seeds of chervil, fennel and lovage, while parsely is popularly used as a garnish.

Other species have medicinal uses. Marsh pennywort was once used to treat whooping-cough and sanicle has long been associated with healing. Powders and decoctions of the leaves and roots of sanicle were used to treat lung disease and dysentery. Cow parsley has been used to treat skin diseases, while ground elder was used to ease gout.



WELL-CONCEALED WHITETHROATS

The common and lesser whitethroats are small, active warblers of undergrowth and woodland edge. Although generally secretive, they may be seen in spring displays and flitting courtship chases.

Grey-headed and brown-backed, with a rich chestnut wing patch, the male whitethroat has a dark tail which it often holds in a vertical position, flicking it to show the white outer feathers. His underparts are buffish, and his throat is indeed white, conspicuously so when puffed out in song. The female is browner and lacks the richness of colour. The legs of both sexes are pale brown, distinguishing the whitethroat (or common whitethroat) from the lesser whitethroat, which has blue-grey legs. Another contrasting feature is that in the lesser whitethroat, both sexes look alike.

The most likely occasion on which you may notice a whitethroat is when it is uttering short bursts of its scratchy song. It sings early in the summer, when it is particularly important to advertise and defend its territory. It often indulges in song flights, shooting skywards to a height of about 15m (50ft) over the hedgerows. Here it hovers uncertainly, jerking this way and that, and sings a few jaunty jumbled phrases before tumbling headlong back into the bushes.

The courtship rituals, too, are conspicuous. The male and female perform hectic 'pursuit flights' round the territory. These rapid movements begin in spring, as soon as the females arrive here from their wintering grounds in Africa – a few days later than the males. Both birds may dive into the vegetation, and then the chase continues on foot, a habit that has earned the whitethroat its colloquial name of 'nettle-creeper'.

The male also advertises himself for the benefit of the female by performing a smart display from a branch tip or other vantage point. He raises his grey crown feathers in a sort of crest and puffs out his body feathers, fanning and cocking his tail. This is accompanied by bursts of song, until he completes the performance by offering fragments of dry grass to the female – hence another colloquial name, 'cut-straw'.

Busy schedule It is quite normal for a whitethroat to arrive as late as early May, and depart in early to mid-August. This allows 12 or 13 weeks for the establishment of a territory, courtship, pair formation, the selection of a site and nest building, and then for the cycle of egg laying, incubation and fledging. There must still be enough time left for a repeat of the cycle for a second brood – starting with the building of a new nest.

Once the second brood is safely on the wing, a complete moult takes place – all the feathers are lost and replaced – before migration south again.

Journey to Africa Almost all our resident birds are en route by late August. Their route takes them south through France, and recoveries of ringed birds suggest that they pause here and there for a few days in north Spain and Portugal. Their body weight increases by about 30% before migration, which is a smaller increase than that of most other migrants. The reason is probably that the

Whitethroat (*Sylvia communis*); brown warbler with richer brown wing colour; length 14cm (5½in).

Lesser whitethroat (*Sylvia curruca*); grey warbler with dark eye-patch; length 13.5cm (5¼in).

Whitethroats lay their first clutch of eggs (left) in May, and the chicks (below) hatch in about 11 days.

whitethroats are able to rely on the food they find during these stops to regain strength before the long flight across the Sahara which follows. On the far side of the desert lies a zone of dry scrub and grassland known as the Sahel, and it is here that they stay during the British winter.

In 1968, bird observatory records tell us that normal numbers of whitethroats left Britain in late summer, but in 1969 the numbers returning showed that a calamitous decline had taken place. Later, the British Trust for Ornithology's annual Common Bird Census indicated that whitethroat numbers in Britain and Ireland had fallen by about 70%.

Several theories were advanced to account for this drastic decline, but over the next two years it became clear that the true cause was the failure of the rains in the Sahel in 1968. The drought severely limited plant growth in the scrub and grassland, which thus supported less insect life, making the supply of food for whitethroats inadequate. The whitethroats were deprived of the food supply with which they built up their reserves for the flight across the Sahara and the majority of the population failed to return.

Nature is full of ups and downs, and in spite of poor rains in several years during the 1970s, this sad history has had something of a happy ending. After being reduced to a rarity, the species is now happily on the increase. It has not yet recovered its pre-1968 numbers–it used to be one of our commonest summer visitors–but now it is not too rare to hear the scratchy tune of a whitethroat when you take a country walk in summer.

The lesser whitethroat This bird conceals itself carefully, just like its slightly larger cousin. Lesser whitethroats are denizens of the deepest of scrubland and hedgerows–often, like whitethroats, on agricultural land. Unlike whitethroats, however, they are also found in orchards, parks, large gardens and in woodland, where they favour the more sizeable trees. Often they use the tops of tall trees as song posts, especially when these are warmed by early sunshine. A good time to see lesser whitethroats coming out into the open is in the early morning sunlight at the edge of a wood, an orchard or a scrub area.

The song (a rather grandiose name for what it is) is much less frequently uttered than that of most warblers. Almost always it is delivered when the bird is perched, often in deep cover. It is a most undistinguished performance–a short repetition of a monotone rather similar to the 'little-bit-of-bread' section of the yellowhammer's song. As in the other warblers of the genus *Sylvia* (including whitethroats), there is a strong 'tchack' alarm call, which is also used as a contact call when a family party moves about.

Loop migration The lesser whitethroat departs in late August, taking a south-easterly course across France and Italy, and crossing the Mediterranean in the vicinity of Greece to reach Egypt. This is a hazardous journey, not only because of the natural hardships of migration, but also because of Italy's flourishing sport of bird-shooting. Those that escape this slaughter follow the Nile Valley up into Sudan.

For the return journey, the lesser whitethroat follows a quite different route from its outward one. The few recoveries of ringed birds that have been recorded point to an overland route, looping round to the east of the Mediterranean and thus avoiding the guns of the Italian sportsmen. This would seem a sensible route indeed!

Above: Ruffling its plumage while brooding the young, this lesser whitethroat shows the white underparts that distinguish it from the whitethroat, whose underparts are buff coloured. Another difference is that its nest is not as neatly made as that of the whitethroat.

Below: A lesser whitethroat leaves the young for a moment to forage for insects and other creatures that happen to be conveniently near the nest.

THE UNDERWATER WORLD OF LUNDY

Much of our current knowledge of the animals and plants living in rocky underwater areas around Britain has been gathered from Lundy–a small island off the North Devon coast which is regarded as one of our finest marine nature reserves.

Above: A view of the south end of Lundy. Lundy is only 5km (3 miles) long and 1km (⅝ mile) wide, but its precipitous granite cliffs rising to 120m (395ft) above sea level provide some of the most spectacular coastal scenery.

The island of Lundy, at the entrance to the Bristol Channel, has always attracted people interested in wildlife and wild places. It is owned by the National Trust and is leased to the Landmark Trust; both bodies are concerned to ensure that Lundy retains its unique blend of history, wildlife and wilderness. The history of Lundy is a colourful one of ancient settlement, pirates and shipwreck. The island currently has about 25 inhabitants who are employed by the Landmark Trust to carry out restoration work on the historic buildings and maintain the attractive cottages and hostels let as holiday accommodation.

Discovering an underwater world The natural history of Lundy has been widely studied on land–there is plenty of information on the grey seal population, and the kittiwakes, razorbills and guillemots that frequent the cliffs and rocks–but beneath the waters surrounding the island is a hidden world which only a few naturalists have been able to explore. Lundy provides some of the most interesting underwater scenery and colourful wildlife to be seen in the British Isles–wildlife which, until about 25 years ago, could only be sampled by the professional hard-hat diver or by dredge.

Now, with the development and widespread use of self-contained diving gear, anyone who is reasonably fit and willing to undergo training can explore the underwater areas for recreation and study. The marine bio-

logists who began diving from Lundy in the late 1960s soon found that the island's marine life was outstandingly rich in species.

Habitats and communities The first thing a diver with an interest in biology will see on swimming from the surface to deep water is that the rocks at shallow depths are dominated by a forest of large brown seaweeds – the kelps or oarweeds.

The seaweeds are attached to the sea-bed but do not have roots; they absorb the nutrients they require from the surrounding water. As with terrestrial plants, they need light for photosynthesis, but light intensity rapidly decreases with increasing depth below the sea surface. The kelp forest continues downwards to a depth where about 1% of surface illumination remains – about 8m (26ft) below low water level off Lundy. Red and some brown seaweeds, however, can survive in much lower light intensity, thriving under a canopy of kelp fronds to depths of about 13m (43ft). The deepest foliose algae, for example *Hypoglossum woodwardii* and *Myriogramme bonnemaisonii*, are found at 21m (69ft).

Above: A brilliantly coloured sea slug grazing a bryozoan. Forty six species of these amazing animals have been recorded around Lundy – many of them rarely found anywhere else in the British Isles.

The richest communities of seaweeds are found on the wave-sheltered east coast where life is less severe than it is on the wave-exposed coasts. Many of them, such as *Phycodrys rubens* and species of *Polysithonia*, have preferred habitats like kelp stipes (stalks) or the pebbles found in the shallow tide-swept areas of sea-bed. It is the wide range of such habitats that, at least partly, accounts for the great diversity of species found around Lundy.

Animal life At depths of 13m (43ft) and more below low water level, animal species – hydroids, sea mats, sponges, starfishes and sea anemones – dominate the rocky sea-bed. Rocks around Lundy extend to depths in excess of 40m (130ft) and to distances of over a kilometre (⅔mile) from the shore in places, finally terminating in a level sea-bed of anything from thick mud, through coarser sediments, to plains of pebbles.

Tidal stream velocity and the severity of wave action are very important in determining the distribution of animal species. Around

Above: *Aglaophenia tubulifera*, with its delicate plumes, is one of the commonest hydroids (sea firs) present around Lundy. The branches are covered in minute anemone-like polyps which gather suspended food from the water.

Left: The common sea urchin is by far the most ecologically significant underwater animal around Lundy. It grazes over the rocky sea-bed, feeding on algae, bryozoa, barnacles and probably anything else it can get its teeth around. Off parts of the coast of Ireland, Scotland and south-west England, sea urchins are so abundant that the rocky sea-bed is kept bare of the majority of erect-growing species.

Above: The beautiful yellow cup coral *Leptosammia pruvoti* is a Mediterranean species that created great excitement when it was found to be living in abundance on some parts of the Lundy coast. The skeleton of this animal is about the size of a thimble.

Below: This map of Lundy shows the extent of the nature reserve and the water depths. Grey seals, lobsters, razorbills and sea fans are just some of the wildlife found on and around Lundy.

Lundy tidal stream velocity can be almost negligible or up to 5 knots, while wave action varies from the severe exposure of the west coast to the shelter of the east coast. Strong currents bring a large supply of food to animals such as sea firs, sea fans and brittle stars, which rely on catching organic material suspended in the water. On the other hand, vigorous tidal streams and storm-induced wave oscillation on the sea-bed dislodge or damage such erect species as the snakelocks anemone and the branching sponges. In sheltered areas, silt is deposited on the rocks and can lead to smothering or clogging of animals' feeding organs.

Animals most suited to the widely differing regimes of water movement and siltation thrive at different sites around Lundy, leading to the presence of a very wide range of communities. Many of the species on sub-tidal rocks, the cup corals for instance, are extremely long-lived and will only survive on stable rock where physical stress is low, yet tidal streams strong enough to keep them and the rocks reasonably clear of silt and supply adequate food.

Sea-bed topography is also important and different species often favour different habitats such as cliffs, caves, boulders and gullies. The northern part of the east coast of Lundy in particular appears to have the right mix of physical conditions to encourage the growth of many species, including some that are near the northern limits of their distribution.

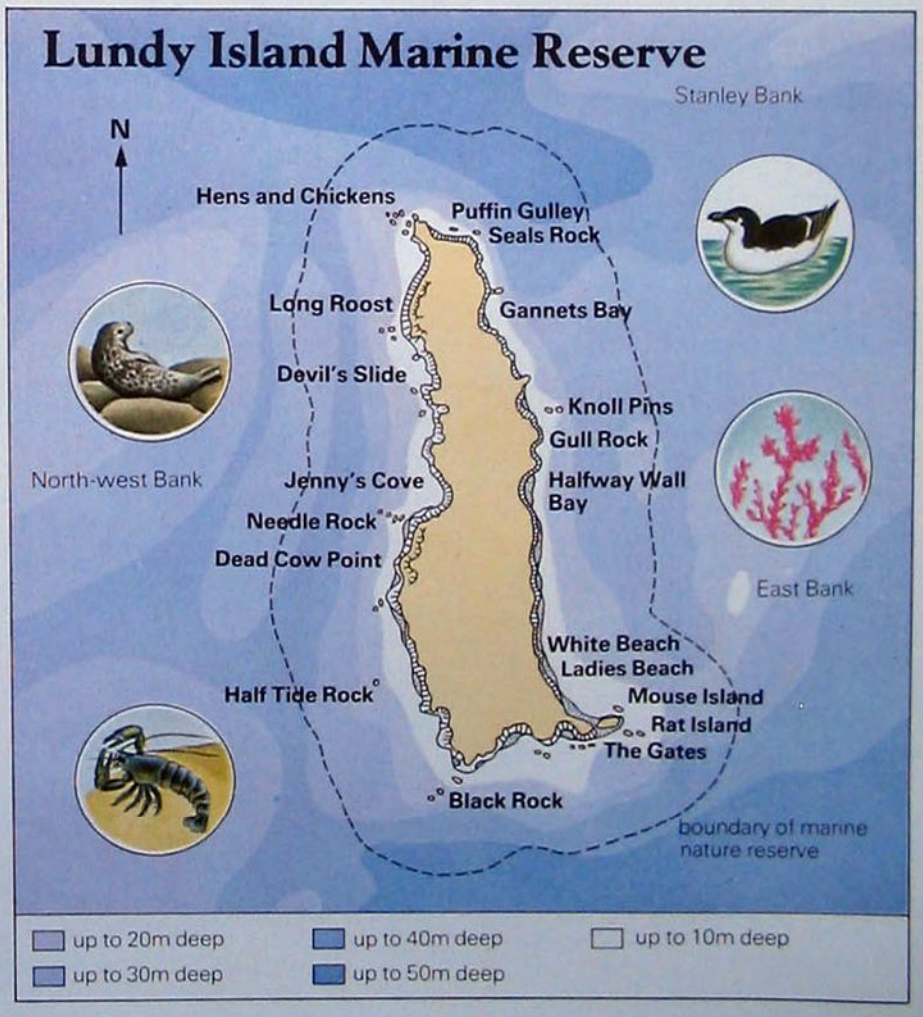
The animals found attached to or crawling over the sea-bed around Lundy are almost all invertebrate species. Rocks around most of the island are dominated by a 'turf' of erect, branching bryozoa (sea mats); they are no more than a few centimetres high but they nevertheless contain a vast array of minute worms, molluscs and crustaceans.

Scattered among this rich turf are large and often highly colourful animals, including sponges, hydroids (sea firs), anemones, cup corals, starfishes, sea urchins and sea squirts. Close inspection of the sea-bed also reveals members of the most spectacularly colourful and diverse group of animals around Lundy – the sea slugs or nudibranchs. Each species is usually highly specific in the selection of prey. For example, *Tithonia odhneri* feeds only on the sea fan *Eunicella verrucosa*.

Desirable 'aliens' The most interesting members of Lundy's underwater community are the animal species that have their centres of distribution well to the south of the British Isles, or which appear to be restricted to coasts near oceanic water. For some reason, these Mediterranean-Atlantic species are outstandingly colourful, with shades of yellow, orange and pink making the sea-bed a veritable garden in full bloom.

One of the most exciting discoveries, made early on in the days of underwater exploration around the island, was the cup coral *Leptosammia pruvoti*, a yellow solitary coral which lives densely crowded on many vertical faces off the east coast. The sea fan *Eunicella verrucosa* is another species rarely encountered further north but common on many parts of the sea-bed around the island. Branches of these flattened fans are covered in minute anemone-like polyps and the colonies face into prevailing water currents so that the maximum surface area is exposed to the suspended food on which the colony feeds. Sea fans are, like many of the species living on the seabed, extremely slow growers. The 30cm (12in) high colonies, which in the past have been considered attractive souvenirs, have taken about 30 years to reach that size.

Fishes and shellfishes The most unusual and



Above: The jewel anemone *Corynactis viridis*. Dense colonies of this lovely anemone cover vertical cliffs and overhangs around Lundy. This colony is only one of many bright colour combinations that the anemone exhibits.

Left: A magnificent lobster peering out of its crevice hiding place. Potting for lobsters and crawfish has been carried out around Lundy for centuries. Continued at its present levels using the same equipment it appears to offer little threat to the wildlife of Lundy. Lobsters hide deep in crevices and small caves during the day but emerge at night to feed, while crawfish live in more open ground, though they are generally seen under overhangs or in gullies.

fascinating of the many fishes found off Lundy is the red band fish. This spectacular red, eel-like fish with iridescent blue markings grows to a length of about 60cm (2ft) and digs vertical burrows in the muddy gravel off the east coast. Until 1974, when the first one was discovered in shallow water off Lundy, the red band fish was known only from trawls taken in depths below 60m (200ft). Following the studies around Lundy, it is now clear that the fish lives curled up in a chamber at the base of its vertical burrow, making excursions out of the hole at dawn and dusk to feed. Three species of wrasse, the ballan, goldsinny and cuckoo, inhabit the kelp forests, and pollack, anglerfish and gobies can also be found around Lundy, as well as many more common fishes.

Other fish visit Lundy on passage and both basking shark and ocean sunfish are usually seen during the summer. Scallops are found in small quantities off the east coast, but fortunately not in commercial numbers. Mussels and cockles can also be seen, and lobsters and crawfish are regularly caught by fishermen using traditional methods.

Conservation The essential feature of most of the coastline and its associated marine life around Britain is that it is in a largely pristine state. Although fisheries, development, pollution, land reclamation and many other activities have taken their toll of habitats and wildlife, we can still look upon most marine ecosystems as a last true wilderness in Britain. Lundy is without doubt one of those incredibly rich areas that require protection and management to ensure their continued value in the future. The island has been a voluntary marine nature reserve since 1973 and, under the Wildlife and Countryside Act 1981, is being considered for scheduling as a statutory reserve.

Right: The habitats around Lundy's coasts are outstandingly suitable for many kinds of nearshore fishes. The kelp forests, the boulder slopes and the broken sea-bed provide the shelter needed by wrasse in particular. The ballan wrasse, the goldsinny wrasse and the beautifully coloured cuckoo wrasse (shown here) are all commonly encountered around Lundy, together with pollack, anglerfish and gobies.

RIVER-SIDE MEADOW FLOWERS

In spring and early summer, river-side meadows are ablaze with a profusion of colourful flowers: golden yellow marsh marigolds, rich blue scabious, deep pink ragged robin, white sneezewort and sometimes the rare chequered purple fritillary.

Above: The colourful flowers of ragged robin (*Lychnis flos-cuculi*) resemble those of the red campion, but the petals are deeply cut into four narrow lobes at the margin, creating the ragged look described by the common name.

Some of Britain's richest areas of grassland, in terms of the number of species that grow there, are those found on the moist alluvial soils of river valleys. Like most areas of grassland in this country, these valley meadows are artificial in the sense that they were originally created by man and, if left completely untended, would eventually revert to the woodland that once covered much of our islands.

Changing meadows During recent years there have been many changes in traditional agricultural methods, and one casualty has been the river meadow. It was formerly flooded in winter, then left during the spring to allow grasses and herbaceous plants to flower, but better drainage of the land today has led to the demise of many water-loving species as their habitat is destroyed.

Once the land has been drained it is suitable for ploughing. What was previously summer cattle pasture may make way for grain crops or grasses. If the farmer chooses to cut the existing meadow early for a silage crop, then the developing flowers or fruit are removed. The plants will often try to produce a second crop of flowers, but these too will probably be removed by a second mowing or by grazing. The plant's limited resources are thus rapidly used up and it may not even have sufficient food reserves to survive until the next year. Sometimes meadows–and water meadows in particular–

Above: The brilliant yellow flowers of the marsh marigold (*Caltha palustris*) are attractive to a great variety of insects, which pollinate the flowers as they crawl about feeding on the abundant pollen and nectar.

Below: Although the stems of the marsh bedstraw can reach up to 1m (39in) in length, they are so weak and slender that they will collapse if the support of surrounding vegetation is removed.

are abandoned as being uneconomical to maintain and the land is soon invaded by more vigorous perennials, scrub and saplings which displace the smaller herbaceous species.

Rare fritillaries Although the flowers that grow in such river-side meadows consist of a varied assortment of species which may be found elsewhere in fens or marshes and other sorts of grassland, some of the flowers found in damp meadows are virtually unknown elsewhere.

One such species is the fritillary or snake's head. The purple flowers of this bulbous species have a chequered pattern that is unique in our flora. More rarely, the flowers are white except for the golden stamens hidden inside the nodding bell of petals. Today, a few sites are maintained especially to encourage the plants to spread.

Pink and red flowers Ragged robin is a more familiar species of damp meadows, as well as of marshes, fens and wood-margins. It has bright pink or rose-red flowers, although white flowers are seen occasionally. The slender base of the petals and the joined calyx lobes form a tube at the bottom of which is the supply of nectar. Because of this structure, access to the nectar is normally restricted to long-tongued insects such as bees and butterflies which pollinate the flowers.

Another species popular with insects–flies as well as bees and butterflies–is the marsh thistle, the commonest of several thistle species growing in damp meadows. The flowers are usually reddish-purple, or occasionally white, and the downy leaves are divided and spiny on the lobes. The young shoots and stems of the marsh thistle, with the spines removed, are used as a salad vegetable in several European countries.

The reddish flowers of the red rattle distinguish it from the similar-looking yellow rattle of drier grasslands. The red rattle is a striking species with purple-tinged stems and foliage setting off the flower spike of purplish-pink flowers, each up to 2.5cm (1in) long. The common name of the species derives from the sound produced by shaking the loose seeds around in the ripe capsules.

Spring and summer gold The marsh marigold is a common species in wet places, producing rich golden-yellow flowers as much as 5cm (2in) across from March onwards. The flowers of this species are curious in that there is no distinction between petals and sepals and the number of petal-like segments can vary between five and eight, with as many as one hundred stamens clustered inside the petals.

The flower head of the marsh bird's-foot trefoil, a relative of the sweet pea and garden pea, is built up from several pea-like flowers. Each floret is a bright golden-yellow, tinged or veined with red, as are those of its more familiar wild relative, the common bird's-foot trefoil. The species can be distinguished by the more robust, upright stems of the marsh variety. If a stem is snapped in two, the marsh plant has a hollow stem while the common bird's-foot trefoil has a solid stem. It also generally grows in clumps, while the marsh bird's-foot trefoil has isolated stems.

One of the more obvious yellow meadow flowers, because of its height, is the common meadow rue. Commonest in the south and east of England, although found up to northern Scotland, it reaches up to 1m (39in) high and bears dense dark green foliage and masses of fluffy yellow flowers. Close examination of the flowers reveals that the petals are actually white, but so small that the conspicuous cluster of stamens gives the flower

its predominantly yellow colour. The plant spreads by means of underground stems called rhizomes so that large clumps are built up, the thick foliage suppressing the growth of other surrounding species.

White flower heads Sneezewort, an attractive little plant of damp meadows, produces flattened, branched heads of creamy white, daisy-like flowers. These each measure 1.5-2cm ($\frac{1}{2}$-$\frac{3}{4}$in) across, and the plant looks like a larger version of yarrow, a related species.

Another white flowered species of river-side meadows, usually found close to free-flowing water, is the marsh bedstraw. It has minute flowers, each with four petals at the end of the stems. Small, backward-pointing stiff hairs on the weak stems and whorls of leaves help the marsh bedstraw to hold on to the surrounding plants.

Water-side blue Sky-blue or pinkish-blue flowers with a yellow 'eye' indicate the presence of water forget-me-nots. These are common in damp grassland as well as by still or running water. Two species are found in river-side meadows. One is *Myosotis scorpiodes* with large flowers measuring up to 1cm ($\frac{3}{8}$in) across. *Myosotis laxa*, also known as the tufted forget-me-not, has flowers half that size, but is slightly more widespread.

The flower heads of devil's-bit scabious are made up of attractive blue, tubular florets which are visited, and pollinated, by butterflies and bees. The plant's common name refers to its stout rootstock which ends rather abruptly, as though it had been bitten off. Many folk tales have explained away this characteristic, one of the most popular being that the devil was envious of the considerable range of herbal properties attributed to the species, and so sought to destroy it by biting off its root.

Left: The delicate flowers of the water-forget-me-not appear in marshy areas from May to August.

1. Sneezewort (*Achillea ptarmica*). Flowers July-Aug. Ht to 60cm (24in).

2. Common meadow rue (*Thalictrum flavum*). Flowers June-Aug. Ht to 120cm (47in).

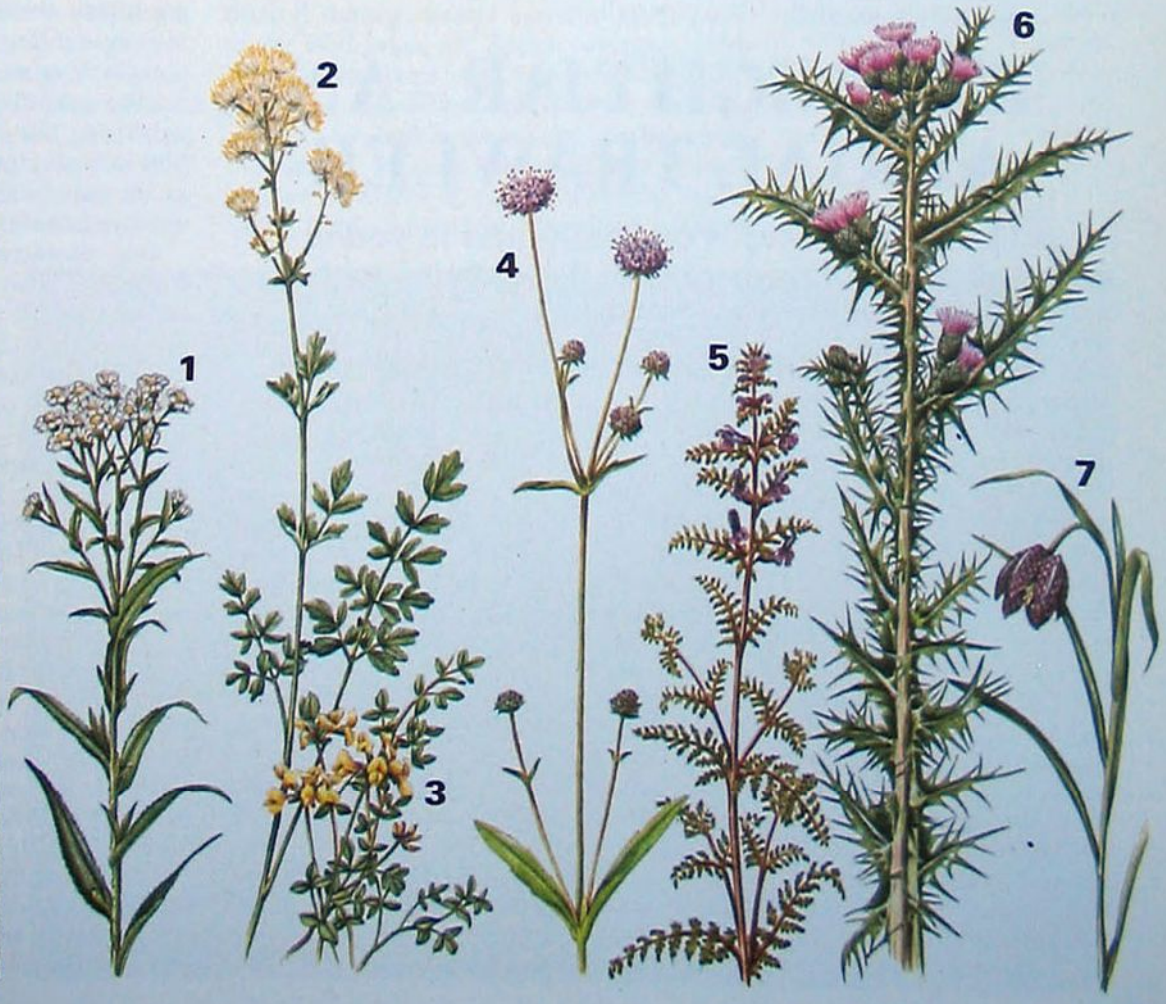
3. Marsh bird's-foot trefoil (*Lotus pedunculatus*). Flowers June-Aug. Ht to 70cm (28in).

4. Devil's-bit scabious (*Succisa pratensis*). Flowers June-Oct. Ht to 100cm (39in).

5. Red rattle (*Pedicularis palustris*). Flowers May-Sept. Ht to 60cm (24in).

6. Marsh thistle (*Cirsium palustre*). Flowers July-Aug. Ht to 150cm (58in).

7. Fritillary (*Fritillaria meleagris*). Flowers Apr-May. Ht to 50cm (20in).



THE NIGHTJAR – AN AERIAL TRAWLER

The nightjar breeds on heaths and in young woodland, and feeds at twilight by flying with its mouth open to catch moths. When perched, it utters a long call quite unlike any other bird's – but surprisingly like the sound of a distant motorcycle.

Above: A fine example of a nightjar's breeding site. The birch-invaded heath offers plenty of open ground or small clearings in which the scrape nest can be located. This incubating female is so well matched in colour and markings with the layer of birch leaves on the ground that if it were not for the egg in this picture, you might not notice her at all.

Nightjars of various species form a world-wide family, but there is only one member that regularly visits Britain and Ireland, and that is the European nightjar, which most people know simply as the nightjar. It is a summer visitor, wintering in Africa, and when in Britain it is generally found on scrubby heaths or in areas of newly planted (or newly felled) forest.

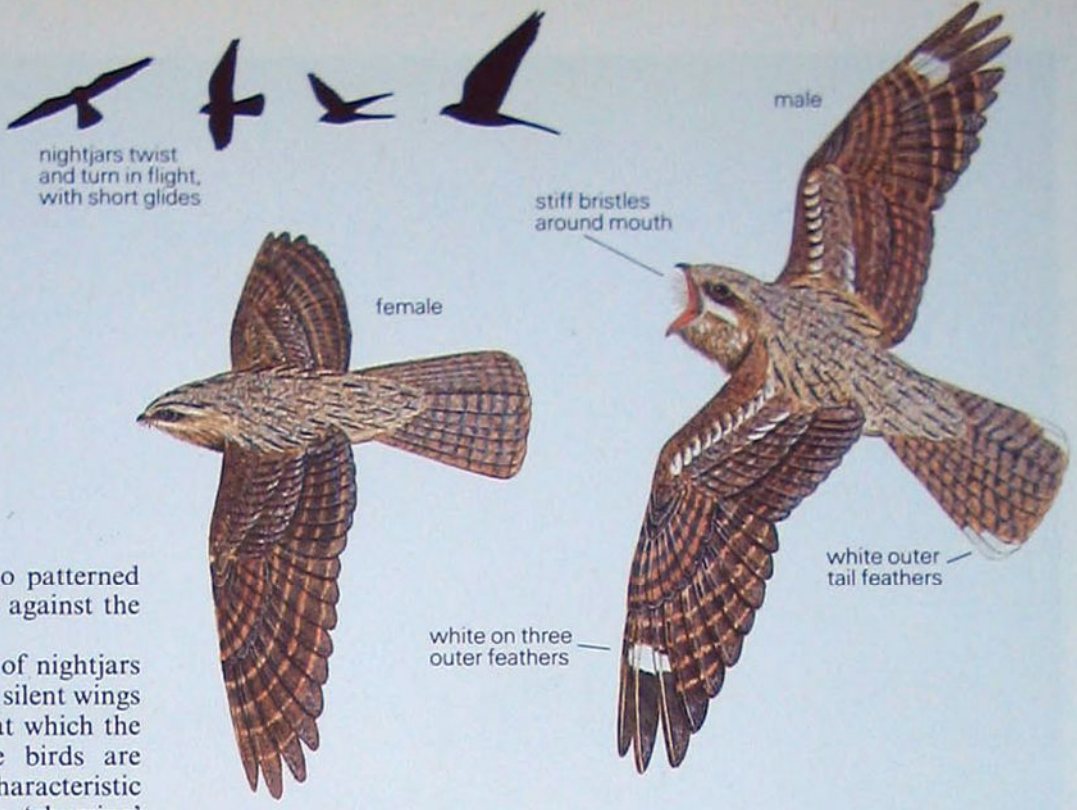
Superb adaptation The nightjar is unique among British birds for its method of feeding: it hawks for moths and other flying insects in the darkness just before dawn and just after dusk. Many of its special features are adaptations to this feeding method.

The nightjar has large, black eyes that are highly suitable for seeing its aerial prey in poor lighting. Its mouth opens very wide, literally from ear to ear, with a wide fringe of bristles spreading out on each side, effectively increasing the size of its 'trawl'. For this is how it feeds: the nightjar catches all its food in its mouth as it flies along, just as if it were an aerial trawler.

One problem arising from this way of feeding is that the nightjar's plumage is showered with the tiny scales that fly from the wings of the moths at the moment of impact when they are caught. The birds must remove these or they will impair the flight efficiency and general functioning of the feathers. Therefore most species of nightjars – including the European nightjar – have developed a special comb on the central toe of each foot. The nightjar uses this comb, in addition to the bill, as an instrument for preening the feathers.

Most birds have preen glands which secrete oil that is used for cleaning and conditioning the plumage, but no nightjar has a well-developed preen gland; it is thought that they use powder-down instead. This substance, which is also used by many species of heron, derives from the tips of constantly growing feathers, mostly on the underparts.

Having fed by daybreak, the nightjar rests during the daylight hours; for this it shows an effective adaptation for safety from predators: its plumage is a superb mixture of



brown, cream and grey tones, so patterned as to cause its outline to be lost against the background.

Sound of a nightjar The sight of nightjars hawking over the heath on swift, silent wings is not usually the first moment at which the birdwatcher realises that these birds are about, for they have a highly characteristic call: a long, almost continuous 'churring' noise. This is generally delivered from a perch, rising and falling in a rhythmic sequence. The calls of nightjars have been timed, and it is found that the churring frequently lasts for more than five minutes on end. It has been likened to the noise of a distant two-stroke engine, and many enthusiasts have been deceived in the past by a motorcycle travelling on some far-off road, causing them to think that it was a nightjar.

Nightjars in spring The first migrants return to Britain in April, and by early May most of the breeding areas are occupied. Although few have been seen on migration at bird observatories, it is estimated that they fly on a set migration route with great accuracy. The males generally arrive first.

Both sexes perform the churring call, possibly from different song-posts. The birds use the sound to advertise their claim to a chosen territory. To establish and maintain the territory, they patrol its boundaries. If they meet their neighbours, they may utter an alarm note, a 'koo-ick' sound, which is also uttered during normal activity, particularly as the bird takes off. Softer versions of this call are sometimes used to give the alarm, and these may be meant only for the breeding partner–or, later in the season, for the young.

Displays between the male and female involve a variety of calls and chases, and a rapid, loud clapping of the wings, which is

Nightjar (*Caprimulgus europaeus*); summer visitor to heaths and young woodland; semi-nocturnal. Length 27cm (10½in).

Below: The middle toe of the nightjar is shaped like a comb and is used in preening the feathers.

Right: Young nightjars hatch about 18 days after the start of incubation. Both the male and the female feed them and they become independent after about five weeks. They make their first flight about halfway through this period, and by the end of it the male will normally have taken on all responsibilities for the first brood–for by then the female usually has a second clutch of eggs which she incubates without any help from him. The second brood is usually hatched in late June, and the young are then ready for the migratory flight by the end of August.

Left: When perching in a tree nightjars, unlike most other birds, sit along the branch instead of across it. In the evening, when they start to fly, the difference between males and females becomes apparent. The males have brilliant white patches on three of the outer wing feathers and on the tail. One of the wing patches is visible in this picture, proclaiming the bird to be a male. These white patches show up very well in flight, and allow the bird-watcher to identify the sex of any nightjar seen in the spring or early summer—but not later, for by then adult-sized juveniles will be about, and both sexes of these lack the white.

mainly done by the male. Up to 25 wing claps are given in a single, sharp fusillade. The male draws attention to his white wing and tail patches by gliding through the air with raised wings. Before mating, both birds stand swaying their tails from side to side, and shortly before mounting the female, the male bounces up and down with spread tail and raised wings. Within a day or two after mating, the clutch of two pale eggs, blotched and marbled with brown, grey or sepia markings, are laid in a simple scrape, usually on open ground.

Breeding sites may include bracken-covered hillsides, but are most often sited near trees. Once again, dead leaves—whether from trees or bracken—form the ideal background for the female's camouflage to have effect while she is incubating. The male's stints at incubation seem generally to be short relief periods at dusk and dawn, to allow the female to leave the nest to feed.

Nightjars normally raise two broods, even where they are at the limits of their breeding range in northern England and Scotland. They then leave the breeding sites and migrate south; some pairs leave as early as mid-August, but some young birds, still unfledged, are found in September. These are often the result of replacement broods, raised late in the season after the loss of the original brood.

Nearing rarity Unfortunately the nightjar is a declining species in Britain and Ireland, in spite of the fact that it is able to occupy many kinds of habitat, and has even been known to nest in industrial tips in suburban areas. A century ago, it was considered a common species, but writers even 50 years ago commented that it was declining. It is, perhaps, the great increase in the ploughing of heathland in World War II, and the continuing destruction of heathland since that time, that have dealt the hardest blows to the species. Even so, nightjars have also gone from areas where new planting of trees provides a seemingly ideal habitat. There are probably now fewer than 2000 pairs breeding in Britain and Ireland.

This situation must be seen as part of the general decline of many species associated with heathland, one of the habitats that has been most seriously affected by urban spread and modern methods of farming. To conserve the nightjar, the same efforts need to be pursued that will save the other threatened heathland species—namely all steps that can be taken to save the remaining heathlands from further encroachment. Otherwise this bird's unique sound will no longer be heard in any part of our countryside.

Below: A nightjar utters a call while sitting on the ground. Its wide mouth is far larger than the beak alone. The size of the mouth may have inspired some of the many folk tales concerning nightjars, for it is often said that the birds suck milk from goats and other farm animals. Indeed, a frequent country name is 'goatsucker', and even the scientific name *Caprimulgus* means the same. It is quite certain, though, that no nightjar could ever feed in this way.

SEA-ANEMONES OF THE SHORE

The sight of sea-anemones scattered along the rocks of a beach is familiar to most people. Yet, few realise that, despite their delicate flower-like appearance, sea-anemones are predators, armed with a battery of stinging cells to capture their prey.

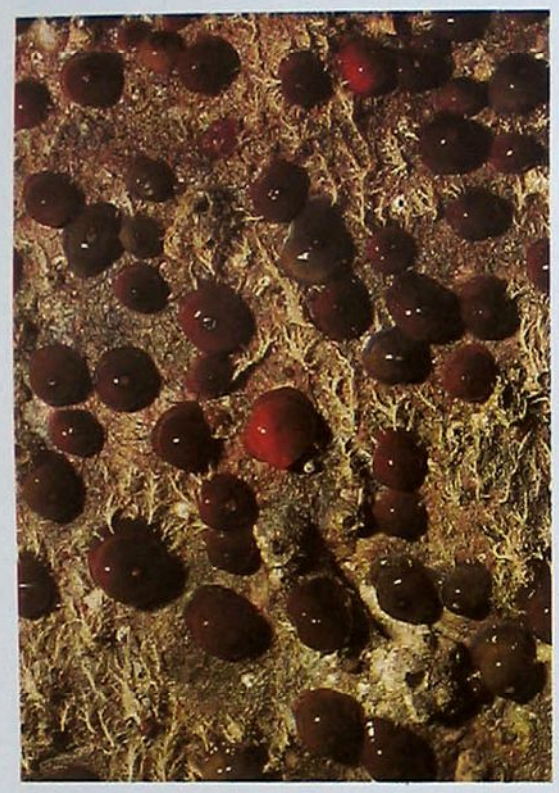
Above: A snakelocks anemone with its characteristic grey or green tentacles tipped with purple. It occurs along the southern and western coasts of Britain in rockpools and on rocks on the sea-bed.

Sea-anemones belong to a group of primitive animals called coelenterates – a group that includes jellyfishes. The word 'coelenterate' comes from the Greek for hollow intestine, a reference to the fact that all members have an internal cavity for digestion.

The body of a sea-anemone is extremely simple, consisting of a sac-like structure with a mouth at one end and a base at the other. The mouth is surrounded by a ring of tentacles armed with stinging cells. When a passing animal – usually a small invertebrate – touches a tentacle, the stinging cells explode and send out microscopic threads to impale it. The victim is disabled and the tentacles pass it into the sea-anemone's mouth.

The base of a sea-anemone is usually modified to form either a sucker disc or a digging organ, depending on whether the particular species lives on rocks or burrows into sand or mud.

Shore-dwelling sea-anemones Many familiar sea-anemones are found on our shores. These species are specially adapted to the hazards of life in this habitat, for being stranded by the tide presents a range of risks. The temperature of the land may be greatly different from that of the sea – on a hot day the rocks are likely to heat up considerably or, at the other extreme, there may be a frost at night. The drying effect of the wind and sun together present another



Above: The beadlet anemone with its tentacles out to catch prey.

Left: A colony of beadlets closed-up to protect themselves while the tide is out. Notice the variety of their colours.

Below: Some of the most common British sea-anemones, with their habitats and lengths (given across their tentacles).
Dahlia anemone (*Urticina felina*). Widely distributed on rocks and crevices on the lower shore. One of the largest British species, growing to 30cm (12in).
Sagartia troglodytes. Common on the undersides of rocks on sandy and muddy shores. Length 3.5cm ($1\frac{3}{8}$in).
Gem anemone (*Bunodactis verrucosa*). Found in rockpools on south and west coasts. Length 7cm ($2\frac{3}{4}$in).
Daisy anemone (*Cereus pedunculatus*). Common along most of the English Channel and the west coast. Length 3.5cm ($1\frac{3}{8}$in).

potential hazard.

Many shoreline species of sea-anemone solve this problem by retracting their tentacles and closing their mouths when the tide goes out. When the tide returns the waves washing over the anemone stimulate the tentacles to open ready for the newly arriving food brought in on the tide.

The beadlet anemone An example of a sea-anemone that closes up at low tide is the beadlet anemone (*Actinia equina*). When retracted, it forms the familiar red, brown or green blobs of jelly that are so often seen on rocky shores at low tide. Indeed, the beadlet anemone is the most common sea-anemone on British shores.

Despite its variable colouring, the beadlet anemone can be easily identified when it is open by a ring of blue warts lying at the base of each tentacle. It occurs all around the coast of Britain, from the middle shore down to a depth of about 8m (25ft). When open it can reach a length of 7cm ($2\frac{3}{4}$in) across its tentacles.

A closely related species is the strawberry anemone (*Actinia fragacea*). Until recently, this was regarded by marine biologists as being the same species as the beadlet anemone, but a different variety. However, it is now thought to be a separate species. In appearance it is very similar to the beadlet anemone, except that it is always red and covered with a pattern of small greenish-yellow dots (hence its name). Its distribution is much more limited than that of the beadlet, being confined to the south and west of Britain. It is also slightly larger, growing to a length of 8cm (3in).

Aggressive anemones An interesting piece of research recently carried out on beadlet anemones has shown that these creatures are not as placid towards each other as they were once thought to be. If, while waving its tentacles to catch food, one beadlet touches another, they begin to fight. First the tentacles are withdrawn and both combatants retreat. Then one arches up and bears down on its opponent, stinging it for two or three minutes. The defeated beadlet moves away, or sometimes becomes detached from its sub-

strate.

The research showed that red beadlets were more aggressive than green ones and almost always won. Green beadlets were, in fact, extremely placid and rarely fought among themselves.

The snakelocks anemone The other species of sea-anemone often seen on our shores is the snakelocks anemone (*Anemonia sulcata*). Unlike the beadlet, this species is not adapted to life out of water since its tentacles cannot be fully retracted; it is usually found in rockpools or crevices just below the surface of the water. Nor is it as widespread as the beadlet anemone, being confined to the English Channel and western coasts from Cornwall up to the north of Scotland.

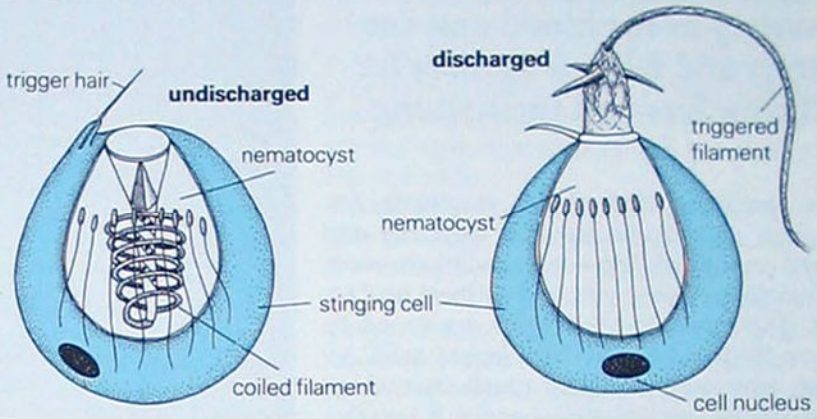
The snakelocks anemone is easily identified by its purple-tipped, green or grey tentacles. Its mouth is surrounded by a pale disc and is slit-shaped; at each end of it there is a conspicuous line radiating away. The snakelocks anemone is considerably larger than the beadlet, reaching a length of 18cm (7in) across its tentacles.

Camouflage for surprise The beadlet and the snakelocks anemones are the most conspicuous British anemones, but there are another eight or so different types to be found on our shores or in rockpools. These species, though widespread, are more difficult to find since they are camouflaged.

In some cases the purpose of the camouflage is to deceive those species of prey that have good eyesight, so that they are more likely to swim into the anemone's tentacles. An example of a sea-anemone showing this type of camouflage is the gem anemone (*Bunodactis verrucosa*). This species has a pink body with rows of white or bluish warts running up it. Its tentacles are beautifully mottled.

Stinging coelenterates

The coelenterates – a group of animals to which sea-anemones belong – are unique among animals in possessing explosive stinging cells with which they catch their prey. Each stinging cell contains a special fluid-filled capsule called a nematocyst, inside which is a long coiled filament. When an animal passes by, a hair on the nematocyst detects it (usually by touch or chemicals) and triggers the cell into action: the pressure of the fluid inside the nematocyst builds up and forces the filament to fly out and pierce the victim. Some filaments are simply barbed at the tip, but others inject venom into their prey to paralyse and kill it.



Left: The beautiful *Sagartia elegans* occurs in a variety of colours. The one shown here is *miniata*, a brown variety growing up to 4cm (1½in) across. It is found all around our coasts and is the only variety of *Sagartia* to occur outside south-west Britain.

Below left: A strawberry anemone feeding on a prawn. Some large species of sea-anemone include fishes and crabs in their diet, but smaller species survive on invertebrates.

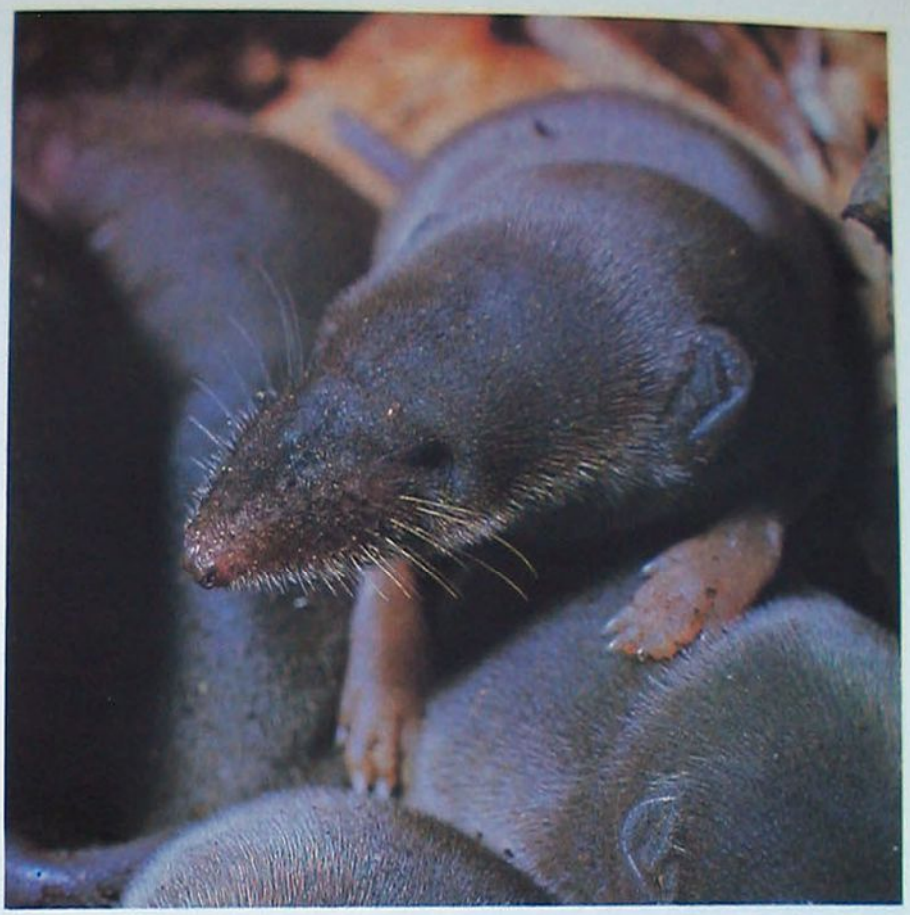
A closely related species is the dahlia anemone (*Urticina felina*). This anemone uses camouflage to protect itself while the tide is out. Like the gem anemone, its body is covered with warts, but on the dahlia anemone these are sticky and collect small pieces of gravel. At low tide, the dahlia anemone retracts its tentacles and resembles a flattened cone of gravel.

Life-cycle As with so many primitive animals, sea-anemones can reproduce both sexually and asexually. In the former, sperm from one individual enters the body cavity of a nearby sea-anemone and fertilises its eggs. In some cases, the eggs develop into juvenile anemones inside the parent's body cavity to be released as miniature adults via the parent's mouth.

In asexual reproduction, an individual simply divides into two. This is particularly common in the snakelocks anemone, where several individuals are often found clustered together in a group, all having derived from a single parent.

MAMMAL PARASITES

Mammals are attacked by numerous parasites–insects, mites and ticks. All take advantage of the rich food supply in the blood and use nests and lairs as shelters for themselves and their young.



Above: A mite just above the left eye of a young common shrew. Mites can cause a foul-smelling mange in dogs and other manges of varying severity in cattle, cats and goats. Mites also cause canker, an ear inflammation, in cats, dogs, ferrets and rabbits.

Most parasites that attack mammals are wingless, and the commonest way they are passed on is by physical contact. Others, such as louseflies, have wings, and fly from host to host. Ticks, on the other hand, are found in places frequented by their hosts, such as rough grassland, and they attach themselves to passing mammals. Fleas' eggs fall into the hosts' nest or lair where the larvae feed on detritus. It is then easy for the next generation to find hosts. This explains why roaming mammals, such as deer, which are without fixed nests, runs and lairs, do not have fleas, and also why they cannot get rid of lice which spend their whole life on the host.

A score of ticks Ticks are some of the commonest and largest mammal parasites. Some feed on only one animal, but others need two or three hosts, one for each stage in their life cycle.

The best known is the sheep tick which may lay up to 3000 eggs in soil debris. The larva climbs up the vegetation and waits for a passing host, on to which it attaches itself by plunging in its proboscis. It remains attached for some days before dropping off, gorged, to change into a nymph which repeats the process before becoming adult. The adult, too, repeats the process, the female remaining attached for one or two weeks before dropping off fully gorged and about the size of a pea. The male is much smaller than the female, and mating often takes place while the female is engorging. The larval and nymphal stages predominate on smaller mammals such as voles, hedgehogs and stoats, and nymphs are also found on rabbits, foxes and dogs. Adults choose larger mammals, commonly sheep, cattle or deer.

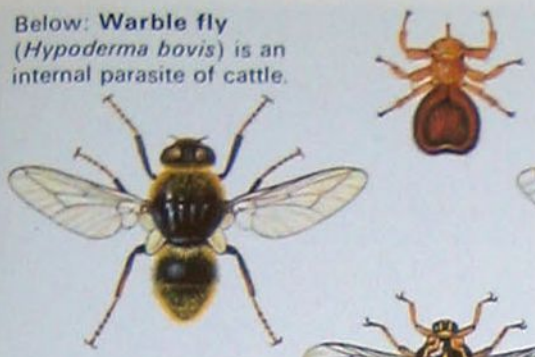
This tick has been recorded in Britain from 20 species of mammal, including man. Many mammals seem to show few symptoms, as long as the parasitization is low, although blood clots and irritation can appear at the site of the bites and secondary infections may cause abscesses. The sheep tick is found on cattle, particularly around the snout and ears, and in the groin. In the British Isles it transmits viruses to sheep and cattle, especially 'louping-ill', an encephalitis of sheep that causes a springing or leaping gait.

Below: A woodmouse suffering from ticks. A few ticks are not serious, but heavy parasitization causes malaise and probably large scale mortality among small wild hosts.

Mites: blood-sucking burrowers Many mammals suffer from mange, a disease inflaming the skin with yellowish crusts, hair loss and intense irritation. Mange is the result of infestation of the skin by minute mites less than $\frac{1}{2}$mm long, the commonest probably being various races of *Sarcoptes scabiei*, the human itch mite, which lives in burrows in the skin. Such mites have been found attacking a variety of mammals including man, horses, cattle, pigs, sheep, dogs, foxes, ferrets, rabbits and squirrels. Picnickers and agricultural workers may be attacked by the larvae of harvest mites, especially in chalky districts.

Gadding cattle Sometimes in summer you can see frightened cattle running wildly

Below: **Warble fly** (*Hypoderma bovis*) is an internal parasite of cattle.



Left: **Sheep ked** (*Melophagus ovinus*) causes mild irritation in sheep.

Right: **Forest fly** (*Hippobosca equina*) is found on ponies and cattle.

Above: **Sheep nostril-fly** (*Oestrus ovis*) lives in the nasal cavities and sinuses.

Above: *Phthiridium biarticulata*, a wingless fly, is found on bats.

Left: Bot-fly eggs are licked by horses. The eggs hatch and the larvae are lodged in the animals' stomachs.

Below: Sheep are dipped to protect them from mites.

around the field with their tails in the air. This may well be 'gadding'. It is caused by warble flies – hairy bee-like insects that lay their eggs on the legs of cattle. The larvae penetrate the skin, wander through the cow's body and end up alongside the spine where they cause lumps, or warbles. Each warble has a hole in the centre through which the larva breathes while if feeds on fluid from the inflamed flesh. The following spring the larva works its way out through the hole, falls to the ground and pupates in the soil. Not only is the hide of the cow permanently damaged, but the flesh is frequently too inflamed for human consumption.

Bot-flies Horses are afflicted by bot-flies which lay eggs mainly on the front legs. The horses lick them off, the eggs hatch and the larvae pass to the horses' stomachs, where they attach to the walls and feed on the tissue, causing indigestion and loss of condition. Different types of bot-flies tyrannize sheep and deer.

The sheep nasal bot-fly swarms around the heads of sheep and lambs, depositing larvae in their nostrils. The sheep become disturbed, shake their heads, keep their noses to the ground, and snort and stamp. The larvae cause a purulent discharge and the sheep find breathing difficult. Eventually both lambs and sheep may be killed.

The red deer throat bot-fly resembles a bumble bee and deer are justifiably terrified of it. The larvae of this species move back down the deer's throat, sometimes finding their way to the lungs, which may kill the host. In spring the larvae are sneezed out of the nostrils.

Louseflies and keds Those who have ridden horses, especially near the New Forest, may have seen blood-sucking louseflies or forest-flies on both horses and cattle. These are flattened, brownish flies that cling tenaciously and move sideways when disturbed. They are often present in large numbers but they seem to cause little trouble to their host, although apparently a horse unused to their attentions can become panic-stricken. The females do not lay eggs, but deposit full-grown larvae, one at a time.

Related to these are other types of fly – the keds of sheep and deer. Deer keds have an interesting behaviour: having found a host – red, roe or fallow deer – both sexes shed their wings. Sheep keds are wingless, and the whole life-cycle is completed within the fleece, the adults looking rather like small spiders in the wool. Sheep do not seem to mind the bites, but may rub themselves against posts and produce sore patches, allowing blowflies to lay eggs.

Bat parasites Bats maintain permanent roosts isolated from other mammals, and this has allowed a number of parasites to specialize in attacking them. They have their own ticks, mites, bugs and batflies.

ROSES OF HEDGES AND SAND DUNES

Of our native wild roses, only the dog rose is at all well known to most people. Yet, there are three other species of rose to be seen in our hedgerows and another that has even become adapted to the seemingly hostile environment of sand dunes.

Opposite: A mixture of field roses (in the foreground) and sweet briars (behind) in flower on the Chiltern Hills. Both are common hedgerow plants in the south of England, though less so than the dog rose.

The dog rose is the most common of our native roses, being found in hedgerows and scrubland throughout England and Wales, but there are three other species of native rose that share a similar habitat. These are the field rose, the downy rose and the sweet briar. Of these, only the field rose is easily confused with the dog rose; the other two species are quite distinct.

The field rose Like the dog rose, the field rose is a climbing shrub covered with hooked thorns with which it anchors itself to supporting plants. Its leaves and flowers are also similar, each leaf consisting of five or seven oval toothed leaflets and each flower having five white petals with yellow stamens inside.

A close examination of a field rose, however, reveals several differences between it and a dog rose. First, its stems are purplish rather than the green colour typical of a dog rose stem. More important are the differences between the flowers. Field rose flowers are scentless and always white, whereas dog rose flowers are always scented and often pink. Field roses also come out later in the year than dog roses – in June instead of May – and they stay in flower longer into the summer.

Another difference between the two species may seem rather obscure but it provides an infallible guide. The difference is in the styles, to be found at the centre of the stamens. In a field rose they are united into a column that protrudes above the stamens, whereas in a mature dog rose (and on every other native rose) the styles are free.

Left: **Field rose** (*Rosa arvensis*). Flowers in June.

Left: **Sweet briar** (*Rosa rubiginosa*). Flowers June-July.

The downy rose The most striking difference between the downy rose and the dog and field rose is that the former is a shrub, whereas the other two are both climbing roses. A closer look reveals another important difference, referred to in the name downy rose: its leaves are densely hairy on both sides. On the field and dog roses the upper leaf surfaces are smooth and shiny and the lower surfaces are hairy only on the veins. The leaves of the downy rose also have a more variable number of leaflets – between two and eight.

The thorns on the downy rose stick straight out from the sides of its erect green stems, which may grow to a height of 2m (6ft). The pink or white flowers are scented and appear at the same time as those of the field rose. Otherwise, they are very similar to dog roses.

Botanists divide the downy rose into three subspecies. One has a similar distribution to the field rose, being common in hedgerows all over England and Wales, but rare in Scotland. The other two subspecies are the common wild roses of Scotland. They are found as far south as the Midlands and, locally, in Wales and Ireland.

The sweet briar Our third less common hedge rose is the sweet briar, sometimes called the eglantine. The name of this plant comes not from its flowers, which are scent-

Above: **Burnet rose** (*Rosa pimpinellifolia*). Flowers in May.

Above: **Downy rose** (*Rosa tomentosa*). Flowers in June.

Left: The hip of a burnet rose differs from other rose hips in having long sepals and being much darker—reddish-purple when young, becoming black at maturity.

Below: The typical habitat of a burnet rose is dry open areas, such as this limestone pavement in the Burren, County Clare.

less, but from its sweet-smelling leaves. The lower surfaces of these are covered with glands that produce an aromatic oil. The fragrance is most noticeable immediately after rain has fallen, when it can be detected some distance away.

The sweet briar is the smallest of our hedgerow roses, with reddish arching stems covered with stiff thorns and stiff hairs. The leaves are hairless and divided into between two and eight leaflets. The pink flowers have the typical shape of a wild rose and appear in June and July.

Although the sweet briar can be seen in hedgerows it is more common in woodland, especially on chalk and limestone soils. It grows mostly in the south of England and Wales, is locally common in Ireland and rare in Scotland.

The burnet rose This is the odd one out among British roses, for it is found on sand dunes and similar dry open areas, rather than in hedgerows. It also has a very different growing habit from the other roses, forming extensive low-growing colonies, with stems branching from creeping shoots to reach no more than 1m (3ft) high.

The plant is named after the burnet saxifrage because of the similarity of the leaves. These consist of seven or nine hairless toothed leaflets. The stems are brown and bear a great many slender, sharply pointed thorns. In shape, the flowers of the burnet

Left: Field roses in full bloom. With its white petals and masses of yellow stamens, the field rose bears a close resemblance to the dog rose. Both are climbing hedgerow plants with hooked thorns, but the field rose is scentless, always white and flowers later in the year; the dog rose is sometimes pink and always scented.

Below: A cluster of ripe field rose hips. Hips are a characteristic feature of all rose species, but they are not true fruits. The fruits consist of small hard capsules called achenes that lie embedded in the fleshy pulp of the hip. Inside each achene is a single seed.

rose are similar to other wild roses but they are always borne singly, never in clusters, as sometimes happens on the other species. The flowers appear in May and are creamy-white or pinkish. The hips are unusual in being purplish-black, maturing to pure black.

Rose hip fruits The multitude of stamens found in rose flowers of all species provides an abundance of pollen for insect visitors of all kinds. The flowers are followed by the fruits – the familiar rose hips. The hips are not, in fact, the true fruits; they are swollen fleshy receptacles. The true fruits lie clustered inside and consist of small dry capsules, each enclosing a single seed.

Rose hips are an important winter source of food for many birds and mammals, including blackbirds, thrushes, mice and voles. The seeds are distributed far and wide in bird droppings or partly eaten hips.

Roses in history Roses have long been important as emblems and in folklore, though most of this has been derived not from the native roses but from two foreign species introduced here by the Romans – the red rose and the damask rose. For example the red rose is the famous emblem of the House of Lancaster. The White Rose of York, however, is supposed to have been a hybrid between the dog rose, the field rose and the red rose. Again, it is the petals of the red rose and the damask rose, not our native species, that were used down the ages for making into potpourris and rose water, for the simple reason that they are much more fragrant.

None of our native roses is grown in gardens to any great extent, though the sweet briar is sometimes planted to make low-growing hedges. Yet, many of our modern hybrid roses owe part of their parentage to these species. The rose 'Frühlingsgold', for example, is a cross between one of the Hybrid Tea roses and the burnet rose.

Robin's pincushion

You may see a hedgerow rose with a moss-like ball of reddish-yellow strands on the stem. These balls are known as bedeguars or robin's pincushions and are galls formed around the larvae of a gall wasp, *Diplolepsis rosae*. In spring the female wasp lays her eggs in the young leaf buds; when the grubs hatch, the gall begins to develop and becomes fully formed in July when the grubs have matured. Many other insects use these galls for shelter, among them parasites and another species of gall wasp. The galls were once ground into a powder and used to treat colic and kidney stones.

NATURE'S LIVING LANTERNS

Bright spots of light glowing in a hedgerow at night indicate the presence of glow-worms – insects which make up for their rather unprepossessing appearance by their display of built-in lights of quite extraordinary brilliance.

Above: The female glow-worm's greenish-yellow 'fire' is intended primarily for courtship purposes. Look for these glowing lights at night among low foliage in an open woodland glade or a grassy hedgerow bank.

Glow-worms are not actually worms, but beetles belonging to the Lampyridae family. About 2000 species of lampyrids, as well as luminous beetles of the Elateridae family, occur in central and southern Europe, Asia, Africa, the Americas and Australasia. In Britain only two species are found, of which one, *Lampyris noctiluca*, is by far the most widespread, although colonies tend to be localised. It is commonest in southern England but also occurs more sporadically in the Midlands and the north, as well as in parts of lowland Scotland and Wales.

The other species, *Phosphaenus hemipterus*, is considerably rarer and now apparently found in only a few localities in Sussex and possibly Hampshire. Neither species has ever been reliably recorded from Ireland.

Attracting a mate Adult glow-worm activity is at its height during the night in mid-summer, although they can emerge from about May to August, depending on the area. The male and female glow-worms differ in appearance, the small male resembling a beetle, while the large female is wingless and resembles a larva. The light they produce is primarily for courtship and mating purposes and comes mainly from the female, whose last three abdominal segments are strongly luminous, emitting a yellow-green light. However, the male has a pair of small pinheads of light which are sometimes visible as he flies above the hedgerows, looking for the female's glow with his large eyes.

Above: The larva of *Lampyris noctiluca* feeding on the liquefied contents of a snail shell.

Below: Male and female glow-worms differ in appearance and structure. The male looks like a typical beetle, while the larger and more frequently seen female resembles a larva. She is wingless and, because of her rather long, heavy body, has slow and deliberate movements reminiscent of a looper caterpillar.

Mating takes place at ground level, when the pair usually douse their lights. The female lays her eggs a few days after mating, usually amid moss or perhaps attached to low vegetation. Individual females lay 50-100 eggs which are spherical, deep yellow and about the size of a pinhead.

Larval lifestyle The small, blackish-grey larva emerges from the egg about a month later, and immediately begins seeking prey, which appears to consist almost solely of various species of snail such as glass snails and young garden snails (*Helix aspersa*). The larva presumably locates its victims by scent and by following their slime trails.

Feeding takes place by a process of external digestion. The larva inserts a quantity of digestive enzyme into the snail's body, which has the effect of breaking down the tissues into a broth-like consistency, enabling the larva to drink up the liquid with its hollow mandibles. The snail shell forms a convenient receptacle for the rendered-down tissue; communal feeding has been observed in glow-worms bred in captivity, a number of larvae ranging themselves about the rim of the snail's shell like piglets at a trough! Whether this also happens in nature is uncertain.

After a meal, the larva is frequently besmeared with the snail's slime and half-digested tissue. It then uses a curious sponge-like device, tipped with finger-like processes, which it extrudes from the end of its abdomen in order to clean itself.

Slow growth Larval development is a lengthy process and it usually takes about three summers before the larva pupates. A larva which hatches from the egg in July of one year attains maturity in the next but one summer. Each winter is spent in hibernation under stones or in crevices in damp, rotting wood.

By their third year the full-grown larvae have reached a length of up to 2.5cm (1in), depending on the sex, and are ready to pupate. They are superficially similar to the adult female, except for the simpler structure of their tarsal (leg) joints, and a series of whitish-brown marks at the lower, outer corner of each body segment.

The pupae of the male and female glow-worms resemble the adults in structure and are easy to distinguish, those of the females being larger, displaying more obvious segmentation and lacking wing pads. Upon emergence about nine days after pupation, the adults immediately begin to glow and seek partners, although this depends to some extent on weather conditions. Activity is most pronounced on warm evenings, especially when humidity is high. Thundery weather is particularly likely to induce a mass display of lights in colonies where numbers may vary from a few individuals to several dozen. The adults feed scarcely at all during their few weeks of adult life, although it is possible that they may take an occasional sip of nectar or honey-dew.

Living light Glow-worm light production, or bioluminescence, is a fascinating and intriguing natural phenomenon. Its most remarkable aspect is the sheer physical efficiency with which it is produced. Unlike all man-made forms of illumination, the light is emitted virtually cold, with no energy being wasted in heat. Light production is effected by controlled oxidation and enzymic breakdown of a substance called luciferin, which is contained in the terminal segments of the insect's abdomen. It is visible on its underunderside as a slightly yellowish-white area.

The light production is made more efficient

Above: Male *Lampyris noctiluca*. Up to 12mm ($\frac{2}{3}$in) long. Has wings and wing cases. Thoracic shield covers the head.

Above: Female *Lampyris noctiluca*. Up to 18mm ($\frac{7}{10}$in) long. Resembles larva, with wingless body, segmented in appearance.

Above: Male *Phosphaenus hemipterus*. Up to 7mm ($\frac{1}{4}$in) long. Rare. Female similar to larva in appearance. Male has short wing cases. Phosphorescent abdomen tip.

Left: By day, glow-worms hide under stones in grassy banks and hedgerows. During courtship, which takes place at night, the wingless female typically attaches herself to the upper part of a piece of low-growing foliage with her glowing tail uppermost. This position gives her the best chance of being seen by the smaller male flying above. To aid his perception of her, the male is equipped with especially large eyes which take up the greater area of his head. His vision is also directed downwards by the overlapping thoracic shield.

by a layer of opaque crystals below the luciferin which acts as a reflector. This prevents any re-absorption of light into the glow-worm's body. The insect is able to exercise complete control over its light output, lighting up or shutting off at will. Even more remarkable, the luciferin seems virtually inexhaustible and self-renewing.

Although most often seen in the adult, light production is by no means confined to this stage. Eggs glow particularly strongly just prior to larval emergence and both larva and pupa have a small light-producing area at the tip of the abdomen. They display their light if disturbed, while the adults, which glow for reproductive purposes, shut off their lights if threatened. It may be that the glow acts as an effective deterrent against some potential predators, depending on the tendency of the predator to perceive and respond to the wave-length of the light. However, frogs and toads have been seen to snap up glow-worms, even when the latter are glowing, although the insects are ignored if they do not move.

Commercial prospect? The efficiency and brilliance of glow-worm light is such that many people have wondered if it might be possible to harness it for human use. Some of the larger and even more brilliant glow-worms and fire-flies have, in fact, been used for serious and semi-decorative lighting purposes in various parts of the world, notably Japan and South America.

Some progress has been made towards manufacturing cold light in recent years, but luciferin has yet to be produced synthetically. Harnessing the natural substance itself presents insuperable problems of collection, since it would involve the extraction of minute samples from a countless number of insects. Even then, the light would not be suitable for widespread public use since its greenish glow renders basic colours black.

Glow-worms under threat Populations of *Lampyris noctiluca* are on the decline, mainly due to destruction of habitats, changing farming practice and increased urbanisation. The disappearance of suitable woodlands and heathlands, the ploughing and drainage of grassy meadows and the widespread use of pesticides all affect the populations. The effects of toxic exhaust fumes on grassy road-side verges – the glow-worm's favourite terrain – is another factor in the species' decline.

Such a decline is particularly significant in species like the glow-worm, where the colonies tend to be widely separated. The chances of re-colonization are reduced by the relative immobility of the female. Another factor affecting population numbers is the tendency of male glow-worms – in common with other night-flying insects – to be attracted to artificial (white) light, often to their destruction.

Below: Mating takes place on the ground. This female has attracted three male glow-worms.

MILITARY SITES AND WILDLIFE

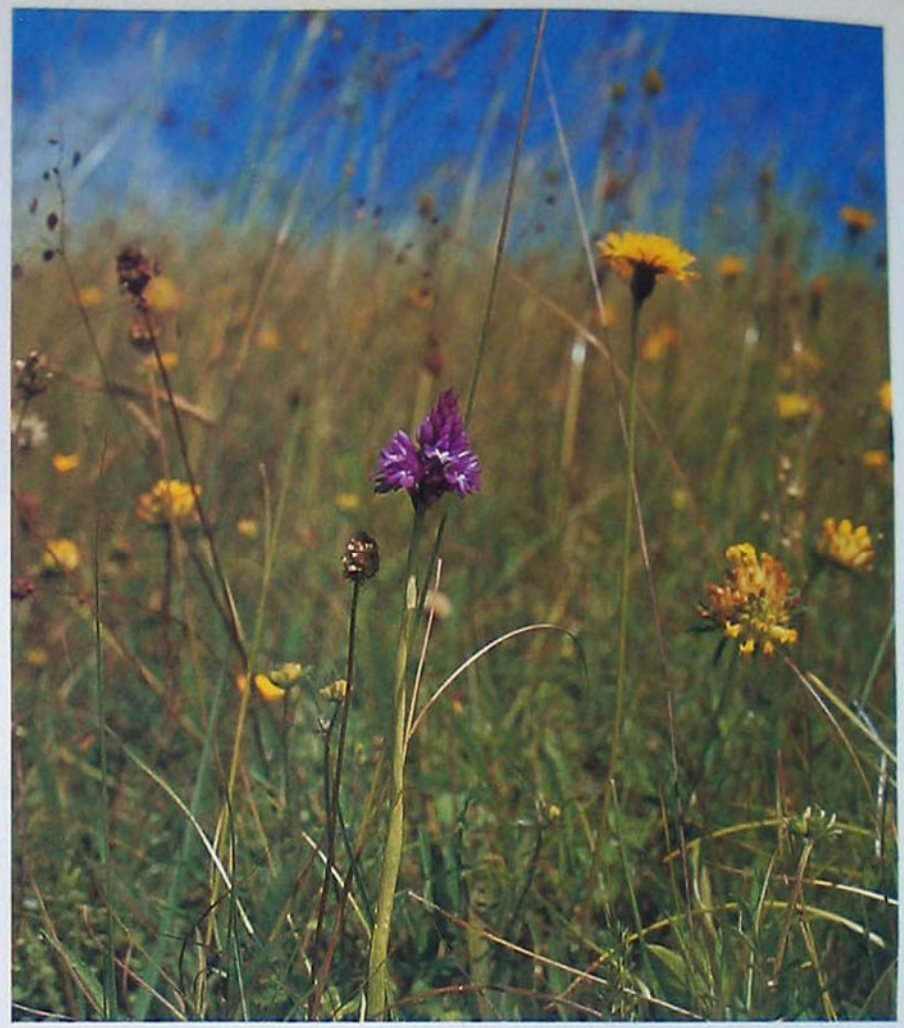
Some of the finest examples of most known habitats in Britain can be found on military land. The wildlife on many of these sites is now recorded by conservation groups.

Most people are aware that the Ministry of Defence (MOD) owns large areas of land on which they conduct a variety of training exercises from time to time. Public access to this land is, naturally, rather restricted.

Until fairly recently little was known about the wildlife that existed on military property. However, in 1973 MOD land became the subject of a searching scrutiny and the investigating committee found itself much impressed with the great diversity of habitats and the richness of the wildlife present at the sites they visited. The committee consequently recommended that a person should be nominated to co-ordinate conservation activities, educate the Services in conservation matters, and establish a close liaison with the many natural history and wildlife societies and organisations.

Setting up conservation groups In 1973, therefore, the MOD appointed an officer, with one assistant, to carry out these functions. It was emphasised that the property was held in the first instance for the purpose of providing the necessary facilities for the Services. The estate management was thereafter to consider agriculture, conservation and access, in that order.

It quickly became essential to start surveys to establish what were the wildlife, habitat, historical and scientific interests at any particular site. The surveys were set in motion by the formation of groups of volunteers, under the guidance of the commander of the particular site, who also co-ordinated the overall activities. The groups naturally contain a high percentage of civilians as, apart from the three Services bird societies, very little, if any, expertise could be found among Service personnel.



Above: Although chalk downland is one of the most heavily used areas for military training, such species as this beautiful pyramidal orchid can still be found on MOD sites. The aim of the MOD conservation groups is to ensure that such plants survive wherever possible.

Below: Another species that flourishes on MOD chalk downland is the yellow hill ant. Here the ants have been able to establish their nests among juniper bushes.

Three experimental groups were formed in 1973 to try out the survey system. Before the end of the first year it was obvious that the surveys were the only way to record and manage the sites. The response to the call for volunteers to assist was great. By 1975 as many as 40 groups had been formed. Gradually interest increased and the Services received much valuable and expert help from a variety of sources.

The situation in 1982 is that over 190 sites are being examined and 150 groups are operating, involving some 4000 Service and civilian volunteers. Two-thirds of the total acreage owned by the MOD is under the scrutiny of conservationists. Ten sites have complete dossiers and material is available to publish a further 30.

Chalk downlands The downlands are one of the most heavily used areas for training by all arms. In spite of this, and the presence of many coniferous trees (which tend to block the growth of many other plant species), beech woods still cap the skyline as they have done since ancient times. Kidney vetch, the foodplant of the common blue butterfly,

provides a bright yellow carpet underfoot, and the beautiful dark pink pyramidal orchid grows in profusion, along with a dozen other species of orchid. Juniper of all ages is a speciality, and it is said that the 18,000 bushes on military property represent 20% of the total population of junipers in the south of England.

Chalk downs can also be the home of the stone curlew–a rare bird. The stone curlews on military land choose nesting sites in an area from which over a hundred species of spider have been recorded, and also nest on one site on the edge of a so-called 'ant-scape'–a fantastic-looking sight comprising over three million anthills with thirty-five billion yellow hill ants in residence. Roe deer have taken advantage of this peaceful habitat and moved in in large numbers–something which has required careful monitoring and, in some cases, management.

Sheep, too, graze the downlands where the rabbits are absent, and many thousands of acres are farmed. And below ground nine of Britain's 15 species of bat can be seen at one site.

Breckland This is a type of open heathland, once common to most of East Anglia, but now confined to a small part of Norfolk, where 17,000 acres are used for military training. Quite a large acreage within the main training area is arable or under afforestation, with up to 10,000 sheep grazing the main part of the breckland.

Surveys to date of the breckland have revealed over 600 species of plant, and 185 species of bird, of which the stone curlew and wheatear are of particular note. To make an accurate record of the insect life will take many years, but a start has been made and a two-year study of one of the meres, which are unique to this part of the country, has revealed over 150 species of freshwater fauna, including the re-discovery of three species of beetle not seen in this country for over 70 years. Perhaps one of the most remarkable facts revealed by the survey is the presence of all six species of deer, with roe appearing in the largest numbers.

Above: The MOD is proud of its coastal conservation sites and specially monitors the effects of the wind, weather and sea on the wildlife there. On these sites species such as the kidney vetch and sea campion shown here are allowed to grow in profusion.

Below: Surveys of sites owned by the military on the breckland in Norfolk have revealed a wide variety of insect, plant and bird life, but perhaps the most remarkable fact revealed by the survey is the presence of all six species of deer resident in Britain. The roe deer (shown here) appears in the largest numbers.

Coastal sites MOD sites located on our coast are prone to more pressure from the elements, and from public usage, than any other. Consequently great care has to be taken in estimating the amount of usage acceptable to the land itself. Close monitoring of the effects of wind, weather and sea is carried out.

The MOD is very proud of its coastal sites, which are mostly used as weapon firing and bombing ranges. There are five marvellous dune sites, all in excellent condition, free from erosion either from military use or the weather and untouched by buildings, cultivation or pesticides.

The richness of the dune sites lies in their plant life. Among the rarities are the coral root orchid and a few plants of the tree mallow, a rare survivor. As many of these sites lie on the main migration routes, they are used by thousands of birds as refuelling and resting places, and they also provide secure wintering refuges for geese, ducks and wading birds.

Lowland heath This is a habitat that is causing great concern nationally and internationally. Heath is a man-made habitat which is fast disappearing due to modern-day pressures–a sad fact since it is a habitat which has developed a very special flora and fauna. Some of the largest dry heaths in the south of England can be found on MOD property and, owing to restricted access, they are being preserved.

The hobby can be seen on these heaths, hunting the emperor moth by day; and at dusk the nightjars take over. There are many hundreds of species of moth to be found, including the eggars, and the sand lizard and the smooth snake, two of our rare reptiles, can also be seen. The wetter parts of the heath, as well as producing a great variety of plants like bog asphodel, the sundews and

Above: Some of the largest dry heaths in southern England can be found on MOD property; because of restricted access these heaths are being preserved –and with them the rare natterjack toad which is still surviving in a few places. Elsewhere in the country lowland heaths are severely under threat of destruction.

lesser wintergreen, also provide some of the best sites in the country for dragonflies, damselflies and the very rare natterjack toad.

Conservation and access The question of how the MOD can reconcile conservation with military training, agriculture and access is often asked. In fact the MOD can and does manage to make these interests work together. The aim is that, provided the military requirement is met, and the safety of the public not endangered, MOD property should be used to the maximum for agriculture, conservation and access. Nearly two-thirds of the large acreage under agriculture is used for grazing, and this is a suitable method of management for conservation. Farmers are co-operative and have assisted in many ways by providing additional habitats and preserving existing ones.

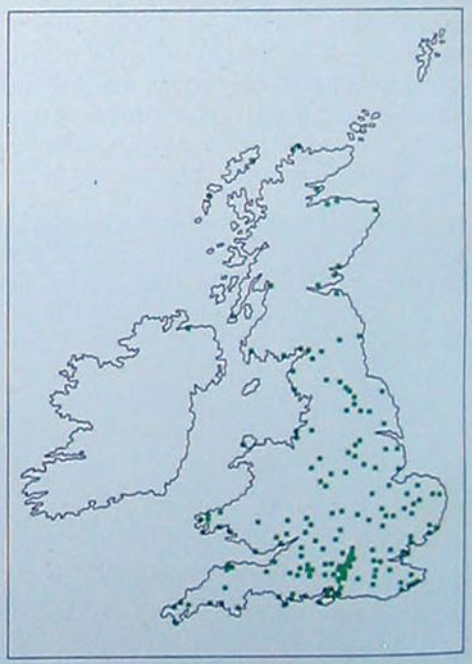
In order for the MOD to retain their chalk downs, heaths, grasslands and woodlands, it has been found necessary to prepare management plans. The beech woods on the downs are suffering from old age and disease and, like all woodlands, require attention. Reafforestation is therefore being planned for at least 30 years ahead. Control methods are in hand to prevent the loss of existing habitat from encroachment by scrub, pine, silver birch and bracken; restriction on the use of fertilisers is carefully laid down; and careful monitoring of wetlands, rivers and ponds gives early warning of pollution or loss of water. All the sites provide ideal research and study areas for experts and students alike.

In spite of the attention paid to conservation and the fact that much of the MOD property is still unsurveyed for wildlife, access has been provided–at sites where security or safety are not involved–for some 30 different activities, including model aircraft flying, riding, motor cycling, walking, sand yachting, shooting and picnicking.

Two such sites are at Castlemartin near Pembroke and Lulworth Cove in Dorset. The MOD welcomes responsible members of the public who respect the countryside code and who appreciate that disturbance is one of the biggest destroyers of wildlife, followed by fire which not only destroys complete habitats but also all the associated wildlife which takes many years to recover. The MOD is continually reviewing the situation in order to provide for access requirements. For information on sites easily accessible and open to the public, contact The Ministry of Defence Conservation Officer, Defence Lands 3, Tolworth Tower, Ewell Road, Surbiton, Surrey.

Below: Round-leaved sundew growing in sphagnum moss. This, and our other species of sundews, grows on military heathland, along with bog asphodel and lesser wintergreen.

Military conservation sites



Many of the military sites in Britain are large and form a high percentage of the chalk downland, breckland, lowland heath and coastal habitats left in Britain. In most cases they are free from pollution. There is little evidence or erosion and access is restricted because of military activities. This map shows the location of some sites.

LOOKING AT BROWN SEAWEEDS

Wracks and kelps are our most familiar brown seaweeds, but the other members of this large and diverse group are well worth searching for.

Brown seaweeds form a class (the Phaeophyta) within the group of plants known as algae. The cells of brown seaweeds contain both the pigment chlorophyll, which gives the green algae and most land plants their characteristic green colour, and also brown pigments such as fucoxanthin, which mask the green of the chlorophyll. Even so, the brown seaweeds vary greatly in colour, and it is sometimes difficult to tell green and brown seaweeds apart.

Seaweed sites Most brown seaweeds, such as wracks and kelp, occur throughout the British Isles and are the characteristic vegetation of most sheltered rocky sea-shores. They are found not only on rocks and in rock pools, but also in caves, crevices and gullies.

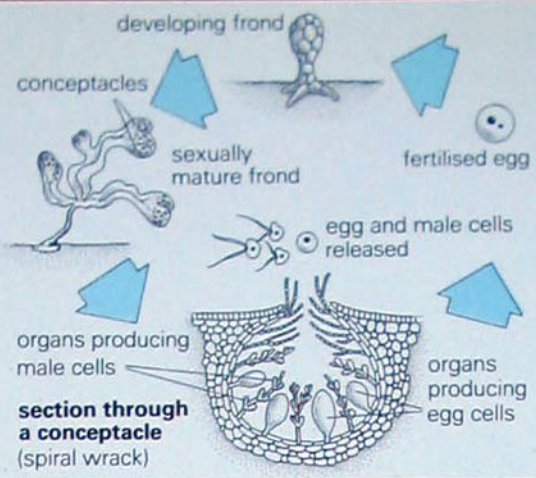
A few brown seaweeds have spread to brackish and even freshwater habitats. One species, *Pilayella littoralis*, commonly occurs in estuaries as well as in the sea, while another –*Fucus ceranoides*– is restricted to estuaries, growing only where it is washed over by fresh water. Knotted wrack (*Ascophyllum nodosum*) grows in knotted clumps on open sea-shores, but in sheltered situations like Scottish sea-lochs it appears in an unusual, completely detached and floating form, covering large areas.

A few species have a very restricted distribution. The strikingly named turkey

Above: The slippery brown fronds and inflated oval bladders of bladder wrack (*Fucus vesiculosus*) are a familiar sight on the sea-shore in summer. It is the commonest of the 200 or so species of brown algae that grow around our coasts. The colour of these brown seaweeds can in fact vary from orange to green; here the bladder wrack is growing over the smooth, greenish fronds of another brown alga, serrated wrack (*Fucus serratus*). A simple test distinguishes brown from green algae. A fragment of green alga placed in iodine solution will turn black, due to the presence of starch in its cells. As brown algae do not produce starch they will not stain with iodine.

Wrack reproduction

Wracks produce male and female cells in conceptacles which appear as small pits or spots on the fronds. In species such as serrated wrack (far right) these are located on separate male and female plants, while spiral wrack (*Fucus spiralis*) produces male and female cells in the same conceptacle (right). In both cases eggs and male cells are released into the sea, where fertilisation occurs.



section through a conceptacle (spiral wrack)

The Japanese invader

In 1972 Japweed (*Sargassum muticum*) was found on our coasts, on the Isle of Wight, for the first time. This seaweed originated in Japanese waters and nobody knows for certain how it came to be introduced here. However, it is thought to have arrived along with Japanese oysters which are cultivated commercially in the English Channel. Although it is related to the wracks, it is very different in appearance, with a narrow, finely divided frond bearing numerous 'leaflets' and flotation bladders. Japweed is now widespread in the English Channel, despite attempts to eradicate it.

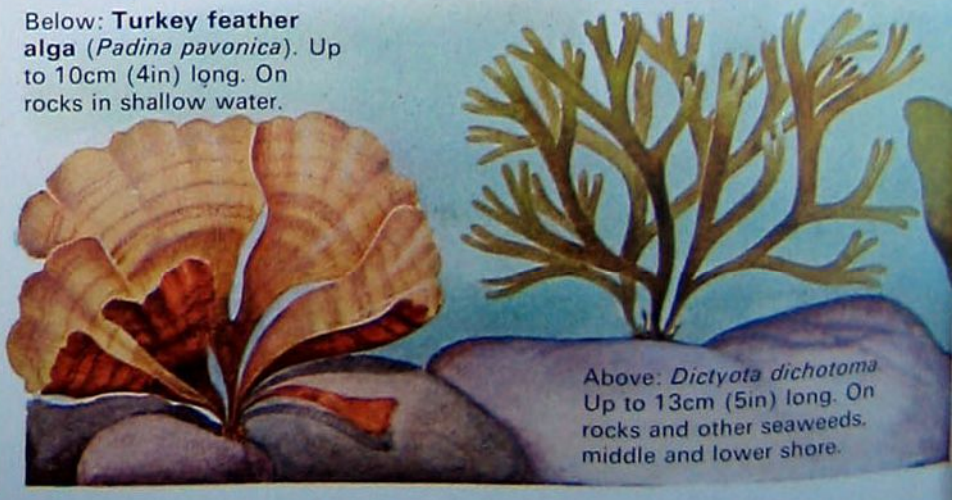
Above: Oarweed (*Laminaria hyperborea*) grows in the lowest shore zone. Its substantial holdfast keeps this alga firmly attached to the rocks on which it grows, and it can support a wide variety of red, green and brown algae which grow epiphytically on its solid stalks. The oar-shaped frond, divided into ribbon-like strips, gives this seaweed its name. Reaching lengths of up to 3.5m (11½ft) it sometimes grows in dense masses in deep water.

feather alga is widespread in the Mediterranean Sea but found only on the south coast in Britain. On the other hand, one of the wracks, *Fucus distichus*, is confined to the northernmost coasts of Scotland. The main factor responsible for these distribution patterns is the temperature of the sea water.

Varied forms Not all brown algae have the fleshy fronds of wracks and kelps. Some are microscopic filamentous plants, only a millimetre or so in length. *Pilayella littoralis* is a small species with a branched, filamentous thallus measuring up to 10cm (4in) in length. *Petalonia fascia* has delicate, flattened blades, while the fronds of *Dictyota dichotoma* are ribbon-shaped and forked. *Scytosiphon lomentaria* is tubular and similar in structure to *Petalonia*, although the shiny, constricted fronds sometimes become hollow with age. The oyster thief (*Colpomenia peregrina*) is also hollow and looks like a small brown balloon. It attaches itself to young oysters in oyster beds and at low tide fills with air. This buoys it up when the tide comes in and it floats away, still attached to the oyster, hence its unusual name.

Other unusual algae are the string-like boot-lace alga which grows to immense lengths, in extreme cases reaching as much as 10m (33ft). The turkey feather alga, also known as peacock's tail, is fan-shaped and its clusters of fronds are lightly coated with chalk. *Ralfsia verrucosa* differs from all the

Below: **Turkey feather alga** (*Padina pavonica*). Up to 10cm (4in) long. On rocks in shallow water.



Above: *Dictyota dichotoma*. Up to 13cm (5in) long. On rocks and other seaweeds, middle and lower shore.

Above: A rocky shore draped with the fronds of serrated wrack. As this species cannot tolerate lengthy periods out of water, it forms a distinct zone on the shore where it is frequently covered by the rising tide.

algae mentioned so far as it is a crustose form which adheres closely to the rock's surface. The body of the seaweed is made up of densely packed upright filaments which make it look as if it is formed from solid tissue.

Zonation The sea-shore is a difficult environment for aquatic plants and animals. Intertidal organisms have to contend with wide ranges of temperature, variable intensities of light and, above all, periods of desiccation and immersion.

Kelps are restricted to the low shore and deeper water because they cannot survive in the higher, drier zone. Wracks, by contrast, have adapted to this environment and form a distinct zone of vegetation over the intertidal area.

However, certain species of wrack can tolerate drier conditions than others. Channelled wrack and spiral wrack grow near the high-water mark, and scientists have shown that these species are actually killed if kept immersed for long periods of time. Bladder wrack and knotted wrack grow in a zone over the middle shore, while serrated wrack, which is the least tolerant of desiccation, grows on the lowest shore levels. The kelp known as tangles (*Laminaria digitata*) forms a narrow zone at or just below low water.

Seasonal seaweeds Most of the larger brown algae are perennial and, in the case of some of the wracks, may take several years to reach maturity. Others are biennial, while many of the smaller brown algae are annuals and show a distinct seasonality. *Petalonia fascia*, for example, develops in spring and early summer and dies back in the autumn. Summer is also the best time to find the seaweeds that grow epiphytically.

Such seasonal growth is related to a variety of environmental factors, such as water temperature, day-length and light intensity. These are also important factors governing the development of the reproductive structures that appear in the perennial species.

Reproduction Most brown algae, apart from the wracks, reproduce by means of alternating spore-producing (asexual) and gamete-producing (sexual) phases in the life-cycle. The two phases are quite distinct.

In kelps and the boot-lace alga, for example, the large plants seen on the seashore are the spore-producing generation. The spores are formed in sporangia, which are joined together into a sorus. This may be seen on a kelp frond as a dark brown patch. Each spore produced has two flagellae which it uses to swim in the sea. Eventually the spores settle on a rock, growing into minute filamentous plants. These develop the sexual reproductive structures. The male organs produce antherozoids, similar in form to the spores, and these swim to, and fertilise, a female cell. From this fertilised cell, the large spore-producing plant develops and the life-cycle starts all over again.

Below: *Chorda filum*. Up to 5m (16½ft) long. In shallow water, often on gravel.

Right: *Scytosiphon lomentaria*. Up to 30cm (12in) long. On rocks and other seaweeds, lower shore.

Left: *Petalonia fascia*. Up to 30cm (12in) long. On rocks and in pools on the lower shore.

ISLAND-BOUND SHREWS

There are four species of white-toothed shrew in mainland Europe, two of which are restricted in Britain to two island groups off the south-west coast.

White-toothed shrews are widely distributed in central and southern Europe, but in the British Isles their range is restricted to the Channel Isles and the Isles of Scilly off the south-west coast of Britain. The greater white-toothed shrew is present on Alderney, Guernsey and Herm, while its similar, but slightly smaller cousin, the lesser white-toothed shrew, is found only on the Isles of Scilly and on Jersey and Sark. Other shrew species are absent from these islands apart from Jersey, where the common shrew is also found.

Look-alikes At first sight both species appear identical, and without close inspection the only way to tell them apart is by knowing on which island each was found. Where one species is present, the other is sure to be absent. In general, the lesser white-toothed shrew is slightly smaller than its cousin and tends to be a little paler in appearance. Careful examination of their teeth reveals that white-toothed shrews have three unicuspid teeth in their upper jaws (fewer than other shrews); these teeth vary in size and shape.

Voracious hunters In most other respects these are typical shrews, needing large quantities of food at regular intervals. Although they are formally classified as insectivores, shrews also consume other creatures to satisfy their carnivorous appetites – including each other occasionally. The bulk of their food consists of arthropods, including insects and their larvae, spiders, and crustaceans such as woodlice. In fact almost any small animal that the shrews come across in their forays above and below ground is likely to be eaten.

White-toothed shrews hunt in much the same way as common and pygmy shrews, tunnelling through the litter layer and tossing aside earth and plant material to probe for prey. Small prey is usually eaten head-first. Both species have been seen to evert their rectums and eat their faeces, a process that allows essential nutrients and bacteria to enter the digestive system.

Lower metabolism White-toothed shrews consume almost their own weight of food every 24 hours, adopting an activity pattern of a half to one-hour feeding period, followed by a one or one-and-a-half hour rest, day and night. Their metabolism is lower than that of other shrew species and if necessary white-toothed shrews can survive short periods of starvation that would be the death of pygmy or common shrews.

Solitary lives Like all shrews, white-toothed shrews spend solitary lives within their own territories. Often these territories overlap, but whereas furious and noisy fights usually break out when two common, pygmy or water shrews meet, white-toothed shrews tend to be less territorial and more tolerant of one another, and fights are rare. In captivity white-toothed shrews have even been known to share the same nest.

The territory of male shrews is larger than that of females, and juveniles have the smallest territory of all. There may be 20 or more territories to an acre, each consisting of an extensive network of interconnecting runways, along which the shrew bustles day and night, searching for food. White-toothed shrews are more nocturnal than other shrews, and total activity during the hours of darkness is greater than during the day.

The nest, a loose ball of soft vegetation, is made in a place that is well covered at the surface, often in bracken or among boulders, or underground below roots, fallen trees or buildings.

The young shrews develop rapidly and

Above: The lesser white-toothed shrew. All shrews are valuable allies of man, destroying vast numbers of insect pests during their short, active lives.

GREATER WHITE-TOOTHED SHREW (*Crocidula russula*)
LESSER WHITE-TOOTHED SHREW (*Crocidula suaveolens*)
Size *C. russula* Head and body 6-9cm (2½-3½in), tail 4-5cm (1½-2in), weight 6-12g (⅛-⅜oz); *C. suaveolens* Head and body 5-8cm (2-3in), tail 2.4-4.5cm (1-1¾in), weight 3-11g (⅒-⅜oz).
Colour Greyish-brown above, with gradual transition from dark to light on flanks. *C. suaveolens* is slightly paler. Both have long hairs on tail and unpigmented (white) teeth.
Breeding season February to October.
Gestation 28-33 days.
Number of young 2-10.
Lifespan Up to 1½ years.
Food Invertebrates, lizards, small rodents, grain, fish.
Predators Barn and tawny owl, kestrel, domestic cat, rat, weasel, fox.

Left: The main physical difference between greater and lesser white-toothed shrews and the other British shrews is self-explanatory: white-toothed shrews lack the orange-red tooth pigment of the common, pygmy and water shrews. Both are about the same size as the common shrew and have velvety greyish-brown fur with duller grey underparts. The ears are more prominent, and on the tail there are distinctive bristly hairs.

females can become pregnant before they are two months old. Little is known about when the family breaks up and the young leave to form new territories. As with other shrew species, it is probable that the mother allows her young to remain in her territory for a time after weaning, and several observations of white-toothed shrews hunting in groups support this.

Caravanning At the age of seven or eight days, white-toothed shrews occasionally begin to exhibit their renowned 'caravanning' behaviour. With their mother as leader, the baby shrews form a chain behind her, each holding on to the fur at the base of the tail of the shrew in front. Sometimes a V formation is made, with two shrews gripping the mother and the others forming two separate chains.

This habit is little understood. Some observers believe it is a response to threat, and that the mother is leading her young from danger. Others believe caravanning is the mother's way of introducing the young shrews to the territory around the nest site.

Breeding As the Channel and Scilly Isles are further south, and therefore warmer, than mainland Britain, white-toothed shrews can enjoy an extended breeding season from February until October.

When a female comes into season, a male enters her territory to mate. The female is initially aggressive and may try to escape. Eventually the male grabs the fur at the base of the female's neck, and during mating she becomes passive. In the wild, females become aggressive again after mating and the male loses interest and departs, but studies of captive white-toothed shrews have shown that males and females will share a nest, even when the female is pregnant, and that males will shelter the young.

After mating the female constructs a nursery chamber of dry grass and leaves which is more solid and compact than the normal loose nest in which she sleeps. The young are greyish-pink, blind and hairless, and each baby weighs only about half a gram. A female can produce up to five litters during the breeding season.

Left: The greater white-toothed shrew is sometimes found in gardens, outhouses and farm buildings, hence its Continental name—house shrew.

Below: The rocky shore and beach of St Mary's, one of the Scilly Isles, a typical habitat of the lesser white-toothed shrew, where it lives among sea-shore vegetation and feeds on small semi-aquatic crustaceans. On those islands where white-toothed shrews occur, they are usually the only species of shrew. Some authorities believe that they are descendants of populations isolated during the last Ice Age, while others consider chance introductions to be more likely.

BEETLES THAT FLY IN THE NIGHT

Both stag-beetles and cockchafers fly readily at dusk and the stag-beetle is a common sight around London, whirring along its way on a warm summer's evening. The cockchafer is attracted to lights and sometimes blunders into lighted rooms.

Above: The mandibles of the male stag-beetle are said to resemble a stag's horns, hence its common name. If molested, the male adopts a threatening attitude, holding its mandibles wide apart. However, the jaw muscles are weak, with insufficient leverage to bite properly, and so they are mostly used for wrestling with other males in the presence of a female. Despite these large jaws, the adult beetles do not eat solid food, but may take some fluids.

Stag-beetles and cockchafers are two of our largest beetles; the male stag-beetle is certainly the longest, although it lacks the bulk of the great silver waterbeetle. Together with the dung beetles they form the superfamily Scarabaeoidea, which takes its name from the Latin for the ancient Egyptian scarab beetle.

Family characteristics Not all the beetles in this group are as large as the stag-beetles, but they all have several features in common. These are: the fat, sluggish larvae, shaped like a letter 'C'; the spiny, digging front legs of the adults; and their antennae, which have a loose, one-sided club at the end. In addition, their eggs are large and oval and are not produced in great numbers–a maximum of about 70 are laid by the cockchafer. They may take over three years to complete their life-cycles. The adults are strong and powerful, but are not agile and move rather clumsily and slowly.

Another beetle feature that can be seen clearly in these large species is the structure of the mouthparts. Beetles have straightforward chewing mouthparts with a pair of strong biting mandibles and two pairs of accessory jaws equipped with feelers or palps, the second pair joined together and forming a lower lip. In the male stag-beetle, the mandibles are greatly enlarged, and are used in aggressive displays.

Stag-beetles can only be found today in the south-east, particularly Kent and Surrey, although they used to occur as far north as Cumbria. Cockchafers are more widespread, being found all over Britain, with a related species appearing in the north, although they, again, are much more common in the south.

Sizeable stag-beetles These large blackish or reddish-brown beetles are a familiar sight from June to August, flying in the evenings or crawling slowly along the pavements of the London suburbs in the morning. Their appearance frightens many people, but they are quite harmless, even though the female can nip if handled.

Male stag beetles vary from 4-5cm (1½-2in) in length to the tip of their mandibles; females have a similar-sized body but lack the elongated jaws. They therefore only reach up to 3.6cm (1⅓in); even so, this is large for a British beetle.

After mating in the summer, the female stag-beetle digs down in rotten, moist tree stumps and roots with her spiny front legs and lays her small batches of large, yellowish brown eggs, each measuring up to 4mm long. She chooses oak for preference, but will lay in other hardwoods such as beech. In gardens, rotten apple tree stumps are often attacked.

Large larvae The eggs hatch into the characteristic white C-shaped larvae with brown heads and large jaws. There are three larval stages before pupation takes place, and the full-grown larvae are bigger than the adults, reaching 8cm (3in) in length and 15mm (½in) in diameter.

The larvae lie on their sides while feeding on the rotten wood. This is not easily digested but it contains cellulose-fermenting bacteria which are taken in by the larvae and retained in their hind intestines in large 'fermentation chambers'. In these chambers, easily visible through the white skin, the bacteria break the wood down into a form which the larvae can absorb.

If you find a larva and pick it up between your finger and thumb it will produce a squeaking noise by working a row of pegs on its hind legs across a toothed ridge on its middle pair of legs. The function of this noise is obscure as the larvae do not have obvious

hearing organs. However, the larvae of some related foreign beetles squeak when a strange larva invades their territory, and it may help to deter intruders from encroaching on their food supply.

After three or four years the larvae are fully grown and leave the wood to make cells in the earth close by, where they change to pupae. The large mandibles of the male are tucked under during pupation, which lasts until the autumn when the pupae change to adults. The adult beetles stay in their cells until the following late spring or summer.

Flight mechanisms Both the stag-beetle and the cockchafer have hard, horny front wings, called elytra, which meet in a straight line down the beetle's back when it is not flying, protecting both the long hind wings and the soft upper surface of the abdomen. The membranous hind wings, which are folded at rest, are the ones used for flying.

When the beetle wishes to fly, it raises its elytra and contracts the direct flight muscles, causing the hind wings to swing forwards. The stiffness and springiness of the membrane

Female stag-beetle
(Lucanus cervus)

Female cockchafer
(Melolontha melolontha)

Above: A male cockchafer. The short grey hairs covering the wing cases give the beetles a rather dusty appearance.

Right: The C-shaped larva of the cockchafer is white with a brown head. The large fermentation chamber visible in the hind intestine helps in the digestion of cellulose.

Below: An encounter between a male and female stag-beetle. If two males meet, they adopt a threatening attitude which is actually all bluff. In fact, the female can give a stronger nip than the male if handled.

Different types of larvae

Although all insects have a basic three or four stage life-cycle, the young stages or nymphs of the 'lower' insects, such as cockroaches and plant bugs, and the larvae of the 'higher' insects, such as butterflies, flies and beetles, are very different.

In the 'lower' insects, the eggs hatch into nymphs, usually with a similar life-style and feeding habits to the adults, differing only in their lack of wings. They do not pupate and the wings develop gradually.

In the 'higher' insects, the eggs hatch into larvae often known as caterpillars or grubs. These usually have a completely different life-style and diet from those of the adults. They do pupate, their wings appearing as pads during this stage.

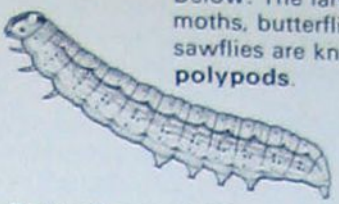
There are four obvious types of larvae, as shown right:

Polypod This means many-legged. The larva is also known as eruciform, from the Latin for caterpillar. It has three pairs of true legs on the thorax and several pairs of false legs on the abdomen.

Campodeiform This active and predatory larva takes its name from its resemblance to *Campodea*, the two-pronged bristletail. It has only three pairs of thoracic legs and usually a pair of tail appendages.

Scarabeiform This also has legs only on the thorax, but is thick and C-shaped. It is typical of members of the dung beetle superfamily but is also found in beetles where the larva has plenty of food close by.

Apodous This is a legless larva with no body appendages. It often feeds inside its food source, where it has no need for legs.



Below: The larvae of moths, butterflies and sawflies are known as **polypods**.

Right: **Campodeiform** larvae are found in some beetles, and lacewings.

Left: Cockchafers and stag-beetles produce **scarabeiform** larvae.

Right: **Apodous** larvae are found in leaf-miners, fly maggots and wood-borers.

Right: The elaborate divided antennae of the cockchafer are a guide to the beetle's sex. A male (shown here) has seven divisions, while the female has six. When the beetle is active, these spread out like a fan.

Below: A male cockchafer taking off from its favourite foodplant, an oak tree. The membranous hind wings used in flight are folded back for protection under the wing cases when the beetle is at rest.

ensures that the hind wings open out fully from their folded position. These beetles tend to fly in straight lines and they are not very manoeuvrable insects.

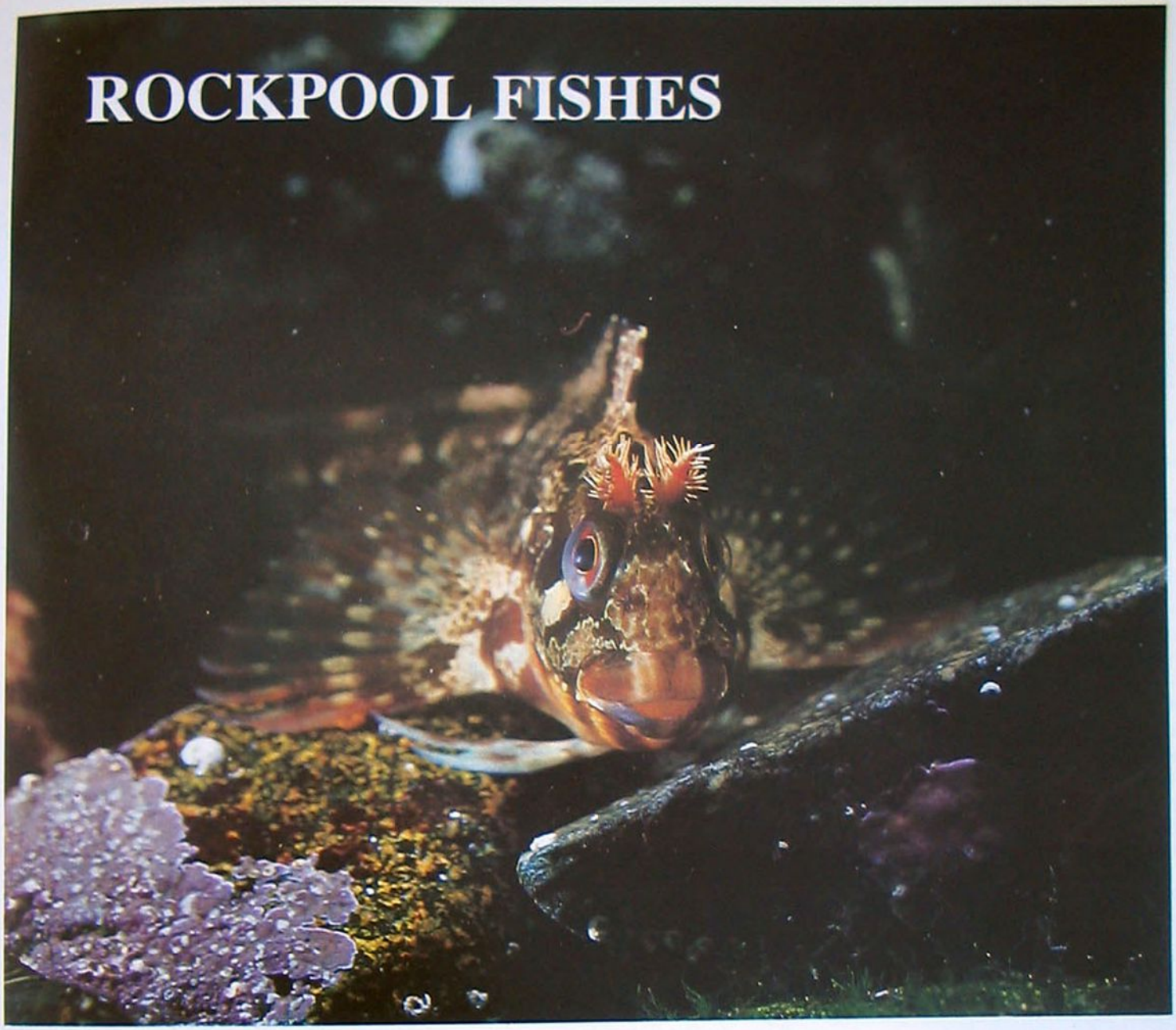
Cockchafer life-style Cockchafers are active and feeding during May, hence they are sometimes called 'May bugs'. They fly strongly at dusk and sometimes appear in swarms around trees and bushes, producing a loud humming or buzzing sound. They feed on the leaves of trees, especially oak, and can cause considerable damage.

They measure up to 2.5cm (1in) long and are blackish, with brown, ridged elytra. The beetles are also covered with short, grey hair, so that they look as though they have been dusted with flour. On the sides, the hair is much denser, forming a series of white triangles. Another easily identifiable feature is the characteristic triangular spiked tip of the abdomen. Male and female can be distinguished by their antennal clubs, which have segments drawn out into 'leaves'–there are seven in the male and six in the female.

After mating, the female digs down about 20cm (8in) into the soil, where she lays batches of 12-20 eggs. These hatch after three weeks into the characteristic C-shaped larvae which, like those of the stag-beetle, lie on their sides. They tunnel in the soil and can be very destructive, feeding on the roots of grasses, cereals and young trees, although the larvae in turn are eaten in large numbers by moles, rooks, starlings and gulls.

The larvae are fully grown by the end of the summer two years after the eggs were laid, that is, in their third summer. They are then 3.6cm (1½in) long and make oval cells in the earth at a depth of 60cm (2ft) or more for pupation. The adult beetles emerge in October but remain dormant throughout the winter; they do not leave the ground until next May.

ROCKPOOL FISHES



Next time you go to the sea shore, take a close look in some rockpools. If you have the patience (and luck) you could see a wide variety of fishes, many of which have adopted some surprising tricks to survive the harsh environment of the shore.

Above: The tompot blenny (*Parablennius gattorugine*) is one of several species of blenny to be found in rockpools around the coast of Britain. The tompot is confined to the rocky shores of southern and western coasts of Britain and Ireland, where it lies concealed among kelp. The bright red branched tentacles above its eyes are a characteristic of this species.

Compared with the equable environment provided by sea water, the shore is a harsh and hostile place to marine life, and the animals that live there have had to adapt themselves to extreme conditions. Twice each day, shoreline creatures are left exposed to the drying effects of the air as the sea ebbs away. In winter, temperatures on the shore may fall to well below freezing point, whereas it is extremely rare (at least, in Britain) for the sea to freeze. In summer, the opposite occurs: the sea remains cool while, at low tide, the shore is subjected to the direct heat of the sun.

Even rain presents a problem, for shoreline plants and animals are adapted to sea water (ie water with a high salt content). To be deluged with rain water, which has a low salt content, can make it difficult for them to maintain the correct water balance inside their bodies.

Life on a shore Despite the rigours of the environment, a wide range of marine creatures have become adapted to life on the shore, whether in rockpools, on bare rocks or buried in the sand.

Among fishes, most species on the shore live in rockpools–not surprisingly, since fishes are much more susceptible to desiccation than many marine creatures and so are more in need of a permanent supply of water, even at low tide.

As well as the threat from the environment, shoreline creatures, rockpool fishes included, face an additional hazard from predators. The number of sea birds that forage on the shore as the tide recedes shows how rich is this source of food. Even mammals such as badgers and foxes hunt on the shore at low

Above: **Montagu's blenny** (*Coryphoblennius galerita*), a rockpool species confined to south-west Britain.

Above: **Sea scorpion** (*Taurulus bubalis*), a superb mimic of its background colour.

tide.

Faced with such an array of predators, rockpool fishes keep themselves well concealed, helped in many cases by the ability to change their colour to match that of their surroundings.

Camouflaged fishes An example of a shore fish that uses camouflage is the shanny. This species, which is one of our commonest rockpool fishes, can turn dull brown when it lives in pools with dark rocks or olive green if it is surrounded by green seaweeds. The shanny is one of the few fishes that are bold enough to emerge while a pool is being watched, but you need to keep a low profile by lying down on the rocks and keeping quite still. The fish easily detects any sudden movement since its eyes are placed high on the sides of its head and its vision is extremely acute.

The shanny is a member of the blenny family of fishes, many of which can be found in rockpools around Britain. Montagu's blenny, for example, is another bold rockpool fish, foraging for its food (mainly the limbs of barnacles) in the open water.

Among British fishes, one of the finest mimics of background colour is the sea scorpion. The colour of this fish can vary from bright green when among the green algae of a shallow pool, or olive brown when under bladder wrack, to brick red when found on the red rocks of the Devon or Pembroke coasts. Needless to say, its colour is no help when it comes to identifying this species, but its broad head and the long spine on each gill cover make it quite unmistakable. These spines are sharp but, despite the name of the fish, they are not venomous.

Seaweed impersonator Perhaps the most remarkable example of camouflage among British shore fishes occurs in the worm pipefish. As its name suggests, this is a slender fish with a rather cute retroussé snout. Not only does its colouring vary to match its background, the shape of its body closely resembles the stems of seaweeds such as knotted wrack and other brown algae. When it hides in either of these seaweeds it is almost impossible to detect. Even when it moves, it swims with a slow gentle motion that perfectly

Above: The shanny (*Lipophrys pholis*) is an extremely common shore fish, found in rockpools and sandy pools. Its colour varies from brown to green, depending on the background, and it may also be blotched, as here.

resembles the swaying of seaweed in a rockpool.

Many other camouflaged fishes live hidden among rockpool seaweed. The corkwing wrasse hides in patches of sea lettuce when young–and is an appropriate green colour. When mature, it changes its colour to match its new habitat of brown seaweed.

Hiding in crevices Most of the fishes mentioned so far live mainly among seaweed, or sometimes beneath boulders, and hide from potential predators by the use of camouflage. Other species avoid detection by hiding in the crevices of rocks, both in rockpools and in areas where the water drains down to the shore.

An expert at this life-style is the butterfish or gunnel. This fish is extremely slippery–hence its name–and, with its thin body, is well able to slip into the smallest of cracks. It occurs on rocky shores all round the coast of Britain.

The five-bearded rockling shares the same habitat as the butterfish and is equally widely

Above: The butterfish or gunnel (*Pholis gunnellus*) has a long slender body ideally suited to slipping into crevices between rocks, where it remains hidden from predators. It is found on rocky shores all around the coast of Britain, even as far north as the Shetland Isles. Notice the characteristic line of spots on its back.

Right: Our most widely distributed rockpool goby is the rock goby (*Gobius paganellus*). It occurs from the Sussex coast westwards, and along the west coast of Britain up to Scotland. It is distinguished from other gobies by its almost black colouring, and is found in pools with dense algal cover.

Above: **Corkwing wrasse** (*Crenilabrus melops*) is green when young, becoming brown when mature.

Above: **Five-bearded rockling** (*Ciliata mustela*) is named after its five barbels.

Above: **Shore clingfish** (*Lepadogaster lepadogaster*) clings to the undersides of boulders and fronds of algae.

distributed. On the southern and western coasts of Britain it is joined by its close relative, the three-bearded rockling. Both rocklings are members of the cod family and, like the cod, have a barbel on their chins. But they differ in having extra barbels on their snouts–two extra on the three-bearded rockling and four extra on the five-bearded species. Hence their names.

Young five-bearded rocklings are particularly numerous on the shore in summer and autumn.

Suckers for survival One of the advantages of living in crevices or among seweed is that the fish avoids the direct force of waves breaking over it and the attendant risk of being swept away. Other species of fish have solved this problem by developing sucker discs with which they attach themselves to the bottom of the rockpool.

Above: Another goby common in British rockpools is the two-spot goby (*Gobiusculus flavescens*), named after the two characteristic black spots on its body. The two-spot goby is unusual among gobies in not being a bottom-dwelling fish. It swims in small schools close to algae, often near the surface. In rockpools it is usually found near brown algae.

The best-known example of a fish with a sucker is the lumpsucker. This is one of the largest fishes to be found in British rockpools, often reaching up to 50cm (20in) long, and it has a deep lumpy body, with a powerful sucker on its belly. It requires considerable force to dislodge a big specimen from a rock. Large lumpsuckers are usually only found offshore, though in Scotland they can be seen in spring near the low-tide mark, guarding clumps of eggs. Young ones, however, are found in lowtide shore pools.

A group of much smaller fishes with suckers are the clingfishes–the largest grows to be only 6.5cm ($2\frac{1}{2}$in) long. The commonest British species is the shore clingfish. The sucker on its belly is, relatively, just as strong as that on the lumpsucker. It can be found clinging to the undersides of stones on the shore or among kelp growing on rocks. Its body is pink or deep red with a pair of yellow-rimmed blue 'eyespots' on the back. Obviously, with this coloration, the shore clingfish is making no attempt to conceal itself, though in the places it inhabits it has little to fear from predators.

Shoreline gobies One of the largest groups of rockpool fishes around our coast is that of the gobies. These all have a sucker-like fin on their bellies, but it is too weak to prevent a goby being washed away by a wave. The most the sucker does is to keep the fish in position in still water as it watches for potential prey or predators.

In rockpools, the most widely distributed species of goby is the rock goby, which can be identified by its nearly black colouring.

Above: Some arboreta specialise in particular groups of trees, oaks or birches, for example. The Winkworth Arboretum, near Godalming in Surrey, has a notable collection of maples (*Acer* spp.). The best time to see them is in October when they show their autumn colours.

BRITAIN'S BEAUTIFUL 'TREE GARDENS'

If you want to see exotic trees then the place to find them is in a specialised 'tree garden' called an arboretum. Britain has dozens of arboreta, from the Isles of Scilly to as far north as Wester Ross in Scotland, many boasting rare species from the distant corners of the world.

An arboretum is primarily a place where trees, and associated plants such as shrubs, are collected so that they can be examined, compared and, not least, simply enjoyed. Some arboreta contain just a score or two of species, whereas the biggest, Hillier's Arboretum in Hampshire, has a collection of nearly 10,000 species, varieties and cultivars.

An arboretum is quite different from a garden. For a start, most arboreta are very much larger than any garden, sometimes covering several square miles. Such an area obviously cannot be maintained to the neatness of a garden, and there is usually little need to do so. Trees are generally able to maintain themselves, and shrub layers help greatly in keeping weeds under control. Arboreta are, therefore, much less formal in appearance than a well-kept garden.

The function of arboreta The most significant function of an arboretum is as a repository for different tree species–a place where living specimens can be studied and compared. Many rare and endangered tree species are grown in British arboreta, a role that is becoming increasingly important as more and more natural forests and plant communities are destroyed. An extreme example of this concerns the tree *Franklinia alatemalia*, which has been extinct in the wild since 1790 but can still be seen growing in arboreta (it was native to the state of Georgia

Right and far right: Many British arboreta have a wide range of unusual and exotic trees.
On the near right is the famous pagoda tree (*Sophora japonica*) at Kew Gardens. This tree was planted in 1753, which makes it one of Kew's oldest trees and the first pagoda tree to be planted in Britain. It is still flourishing, despite its need for supports. On the far right is a group of Chusan palms (*Trachycarpus fortunei*) at Borde Hill gardens in Sussex. This species is one of the few palms to grow well in Britain.

in the USA).

The importance of this role can be seen when it is considered how many of our drugs, foods and other items are obtained from plants, trees included, yet few endangered trees have so far been tested for their potential.

Tree testing Another important function carried out in the larger arboreta is to test the hardiness, growth characteristics and speed of growth of newly introduced tree species. In this way botanists can determine which trees have forestry or amenity potential in this country.

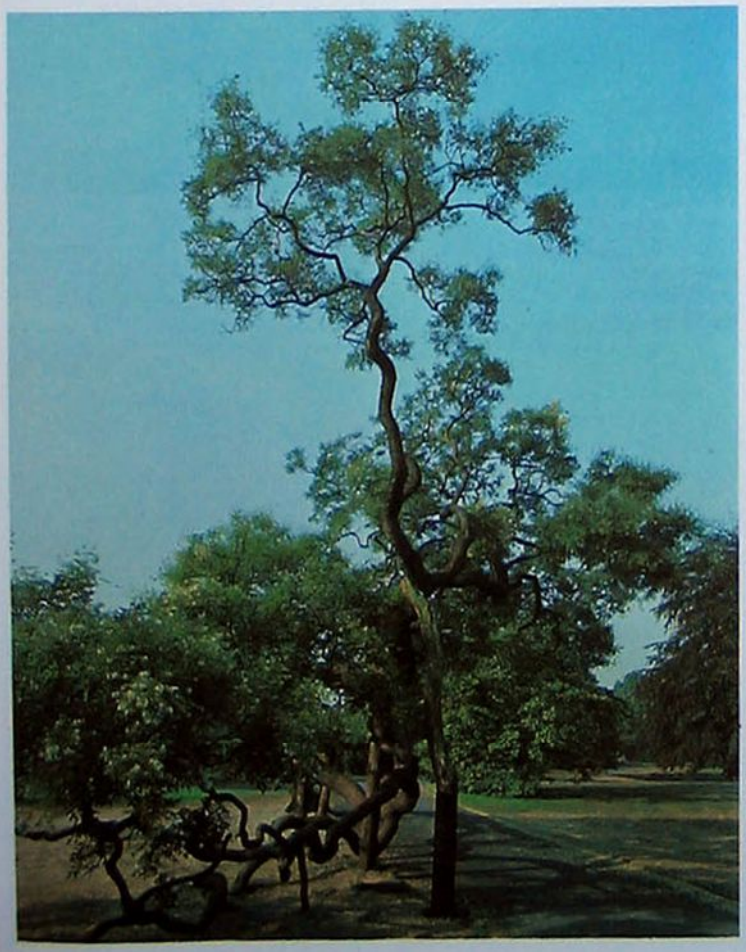
Once it has been decided that a species shows promise, samples from different parts of its native range are tested to discover whether trees from any particular locality offer a significant advantage. For example, the Sitka spruce was first discovered to have great potential as a source of timber in Britain after being tested in an arboretum. Subsequent tests showed that Sitka spruces from north-western United States grow fastest in Britain, but that they are susceptible to frost damage here. On the other hand, specimens from Alaska, the far north of the tree's native range, were found to grow too slowly here. The best specimens came from British Columbia in Canada; they grew fast but were also hardy enough to survive frosts.

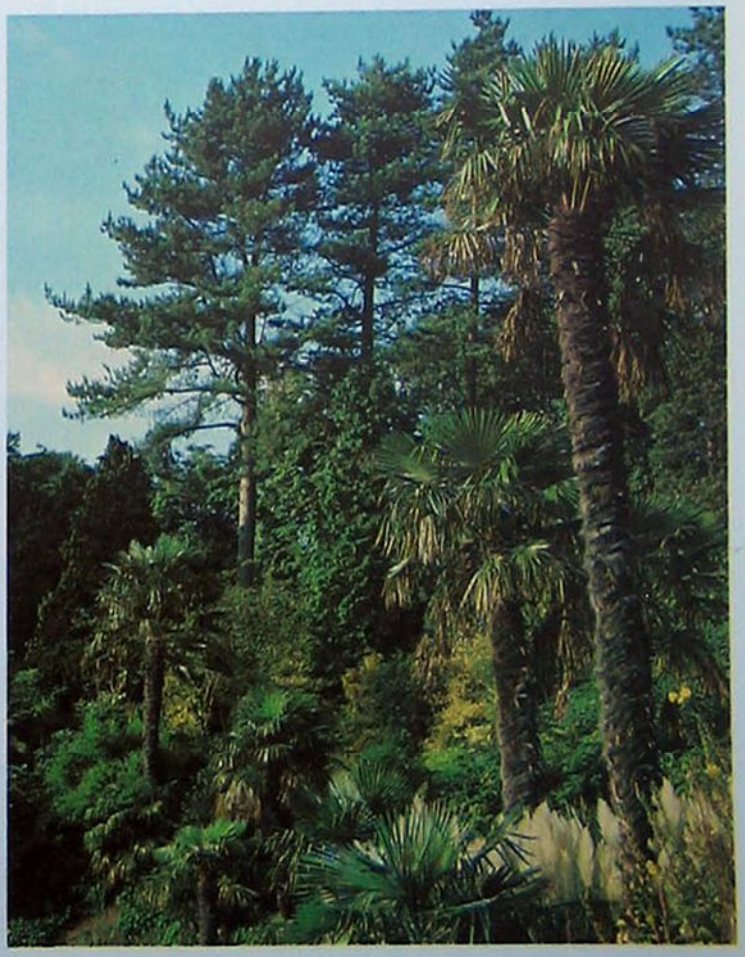
Arboreta also play an active role in plant breeding, first to discover parent trees that might make useful hybrid offspring, and also to compare the qualities of hybrid trees with those of pure species.

Arboreta for pleasure To the general public, the most important role of an arboretum is as a place of beauty and amenity. Even to someone who has little knowledge of trees, an arboretum can be an inspiring place at any time of year. In spring there is the brilliant fresh green of young leaves emerging; in summer there are the spectacular flowers of trees such as the sweet chestnut and laburnum to be enjoyed, followed in the autumn by the reds, browns and yellows of the dying leaves. Even in winter an arboretum is still worth visiting, for there are likely to be evergreen trees, both coniferous and broad-leaved, to be appreciated. With deciduous trees, winter is the best time of year for studying their barks and habit of growth.

History of arboreta Historically, the development of arboreta in Britain has been closely linked to the introduction of foreign tree species. There are about 35 species of trees native in Britain. Along with some new species introduced here by the Romans (such as the walnut and possibly the sycamore), these were the only trees found in Britain until the 16th century.

From 1500 onwards new species began to be brought back to Britain as explorers opened up new lands. At first these introductions were on a small scale, but they gradually increased over the following few centuries. By the middle of the 18th century enough new trees had been introduced to make the establishment of an arboretum an





attractive idea. The Kew arboretum dates from this time.

Initially, arboreta were simply gardens with a collection of trees in them. They only developed their own distinct style separate from gardens during the early part of the 19th century, when a whole range of new species from western North America suddenly started to appear in this country.

The boom in new trees began with the botanist-explorer David Douglas, who brought back many notable species, for example, the Douglas fir and the Sitka spruce.

During the 1850s, Douglas's work was followed up by a group of Scottish landowners who called themselves the Oregon Association. They sent botanists out to the west coast of North America, the new species they brought back being planted by the landowners as so-called 'policy' woods. These are mixed plantings, established both for pleasure and to test their forestry potential, and are often seen close to the castles of Scottish landowners. The Oregon Association was responsible for the introduction of the western hemlock and Lawson's cypress.

The work of this Association began a craze for planting private arboreta, helped by a flood of new material that has arrived in this country during the last hundred years, particularly from the Far East.

Arboreta today Even today, most arboreta are still private establishments, with their own independent means of support. However, they have been badly hit during the last 30 years by the combined effects of inflation and excessive taxation, and their numbers are declining.

Of the rest, some notable arboreta are financed by Local Governments, universities or charitable trusts, particularly the National Trust–for example, Stourhead in Wiltshire and Bodnant in Powys are both National Trust properties. Most of the remaining arboreta, however, are funded by Central Government. These include the Royal Botanic Gardens, several Forestry Commission arboreta and the gardens in Windsor Great Park, which are run by the Crown Estate.

Above: One of the functions of arboreta is to carry out scientific research. Here, different methods of treating tree-wounds caused by the removal of branches are being tested on a Swedish whitebeam (*Sorbus intermedia*).

Below: Some of the larger arboreta that are open (if only occasionally) to the public. In addition, many National Trust properties, historic houses and even some local parks contain good collections of trees.

Gazetteer of British and Irish arboreta

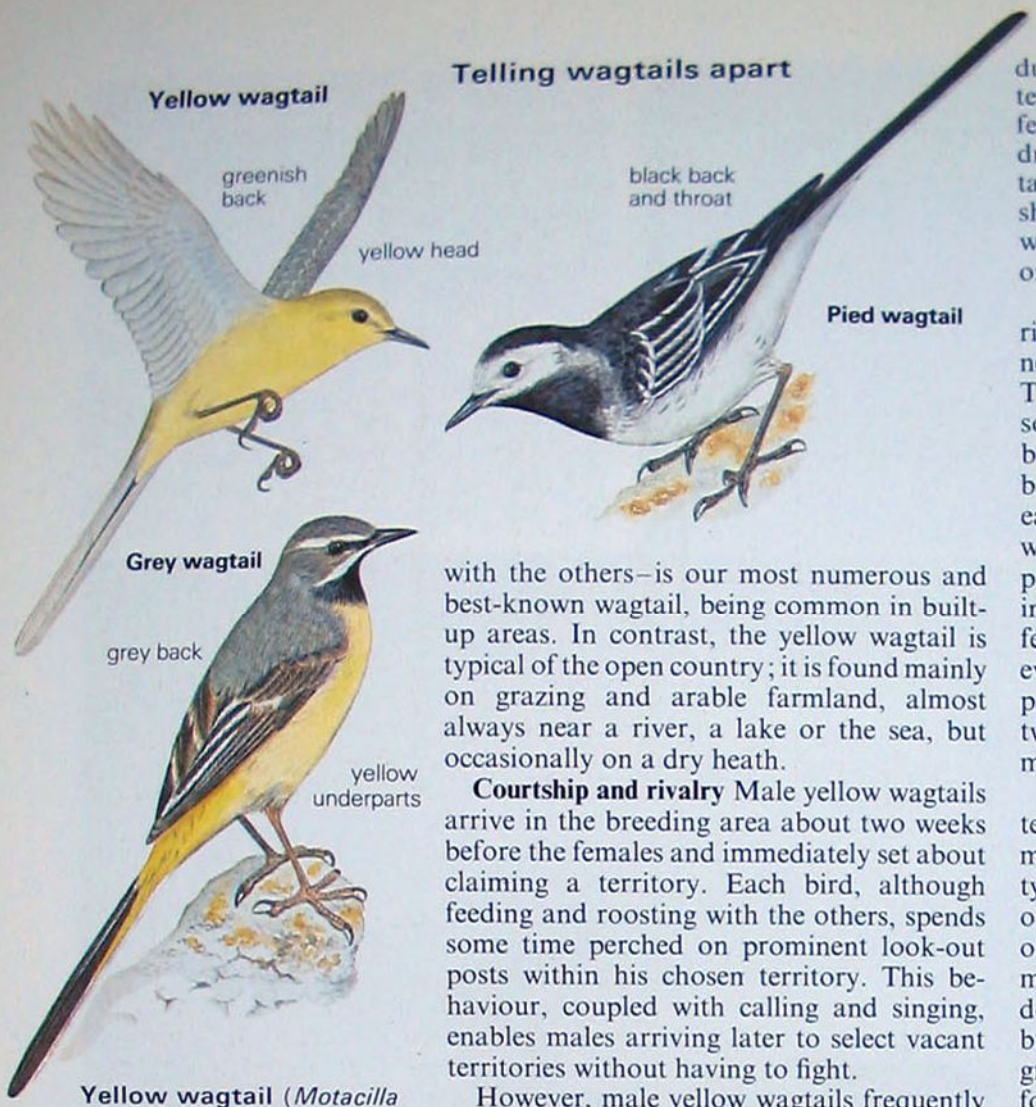
1 Royal Botanic Garden, Kew, Surrey. The foremost botanic garden in Britain; numerous rare species.
2 Savill and Valley Gardens, Windsor Great Park, Berks.
3 Royal Horticultural Society, Wisley, Surrey. A number of good collections.
4 Winkworth Arboretum, Godalming, Surrey.
5 National Pinetum, Bedgebury, Kent. Very wide range of conifers.
6 Wakehurst Place, Ardingly, Surrey.
7 Borde Hill, near Haywards Heath, Sussex.
8 Highdown, Goring, Sussex.
9 Hillier Arboretum, Amptfield, Hants. Largest collection of specimens in the temperate world.
10 Exbury Gardens, near Fawley, Hants.
11 Bicton Gardens, East Budleigh, Devon.
12 Trewithin, Cornwall.
13 Tresco Abbey, Isles of Scilly. Many tender trees, particularly from the southern hemisphere.
14 Stourhead, near Mere, Wiltshire.
15 Bath Botanic Gardens, Avon. Small collection of unusual trees.
16 Westonbirt Arboretum, near Tetbury, Glos. A large and splendid arboretum.
17 Cambridge University Botanic Garden, Cambridge.
18 Hergest Croft, Kington, Herefordshire.
19 Powys Castle, Welshpool, Powys. Some very tall trees.
20 Bodnant, Gwynedd.
21 Castle Howard, Yorkshire.
22 Thorpe Perrow, Bedale, Yorkshire.
23 Dawyck, Stobo, Peeblesshire.
24 Royal Botanic Garden, Edinburgh. A notable collection.
25 Younger Botanic Garden, Benmore, Strathclyde.
26 Castlewellian, Newcastle, Co. Down.
27 National Botanic Garden, Glasnevin, Dublin.
28 Powerscourt, Co. Wicklow.
29 Birr Castle, Co. Offaly. Enormous collection.

THE WANDERING YELLOW WAGTAIL

The yellow wagtail's unwritten language of calls and displays ensures a successful breeding season but, unlike our other wagtails, it avoids the cold British winter, when insects are scarce, by migrating to Africa. It returns in April or May.

A shrill musical 'tsweep' frequently betrays the presence of yellow wagtails when they first arrive in this country in April or May. Their slender, delicately shaped bodies, white-edged wagging tails and long black legs immediately identify them as wagtails, and the bright, canary yellow underparts and yellowish-green upperparts confirm that they are yellow rather than pied or grey wagtails.

The grey wagtail, too, has yellow underparts, and you could mistake one for a yellow wagtail, but the grey wagtail has slate-grey upperparts and a longer tail, and it always lives by shallow, fast-flowing streams. The pied wagtail–coloured black, white and grey and therefore unlikely to be confused



Yellow wagtail (*Motacilla flava*); summer visitor to farmland and open country near water; 16.5cm (6½in).

Below: The female has yellow underparts but is duller than the male.

with the others—is our most numerous and best-known wagtail, being common in built-up areas. In contrast, the yellow wagtail is typical of the open country; it is found mainly on grazing and arable farmland, almost always near a river, a lake or the sea, but occasionally on a dry heath.

Courtship and rivalry Male yellow wagtails arrive in the breeding area about two weeks before the females and immediately set about claiming a territory. Each bird, although feeding and roosting with the others, spends some time perched on prominent look-out posts within his chosen territory. This behaviour, coupled with calling and singing, enables males arriving later to select vacant territories without having to fight.

However, male yellow wagtails frequently have to fight for a mate. Females are easily recognised by their browner backs and paler breasts. Within only a short time two or three different males may try to pair with the first female to arrive in the breeding area. Males have a special, though rather brief, introduction or pairing display in which they patter around the new arrival with breast feathers puffed out, tail fanned and wings dragging on the ground. Although the female takes little apparent notice of these advances, she usually accepts the first male she meets, whether a relatively dull one-year-old bird or an older, brightly coloured individual.

The trouble starts when neighbouring territory-holders, attracted by the calls of the newly formed pair, come in search of a mate. The resident, paired male is able to chase off some of these intruders without any difficulty, but others can be very persistent. Fierce battles sometimes last for an hour or more, each bird flying at the other, lunging forward with beak and claws, and adopting aggressive postures in an attempt to beat the opponent into submission. Fortunately, the shortage of females is only temporary and most males eventually find a mate. Once the birds have paired, scuffles sometimes break out where two territories meet, and then the females may also join in.

Peace returns When these questions of territory and pairing have been settled, the males continue to sing from their song-posts, typically a low branch, a fence-post, a piece of farm machinery or even a prominent clod of earth. Sometimes they display to their mates in a beautiful song-flight. They flutter down at an angle, singing a robin-like trill, but bound back upwards before reaching the ground, to sing on a second and third, or even fourth descent.

The act of mating happens only after the male's hovering display. Initially he runs or pirouettes around his mate, as he did in the introduction ceremony, but then he leaps up and hovers immediately over her, again with puffed out feathers and fanned tail. The

female responds by twirling round several times on the spot and lifting her tail vertically, and then they mate.

A nestful of eggs Yellow wagtails are usually single-brooded, but occasionally there is time to lay a second clutch, so there is good reason to start nesting as soon as there is sufficient food coupled with fine weather. A nest takes as little as four days to build, so allowing five days to lay eggs and 12 to 13 days for incubation, pairs formed in early May commonly have nestlings to feed by early June.

Within the territory there may be several possible nest sites: the base of a grassy tussock, a hollow covered by a large leaf or even a spot beneath an overhanging clod of earth. The female tries each out for size, squatting down and scraping out a hollow with her feet; although her mate may watch, she makes the final choice. She also builds the nest, travelling up to half a mile to collect beakfuls of dry grass for the main structure, and hair, wool or fur for the lining. Whether in the middle of a water meadow or out in a cabbage field, the nest is always well hidden, and sheltered from bad weather.

The eggs are greyish-white, closely spotted with brown, and are most commonly laid in May. Five or six eggs, one laid each day, are the usual clutch. Instead of feeding his mate, the male takes a small share of the incubation. Change-overs are very secretive, one bird calling the other off the nest only when the coast is clear, and often from a distance of about 50 yards. To avoid attracting predators, the relief bird runs rather than flies to the nest, usually taking an indirect route.

Preparing to leave In late July and August all yellow wagtails moult–in preparation for the long journey to their wintering quarters–and at this time they are rather quiet and withdrawn. In their winter plumage, males and females are both relatively drab and difficult to distinguish. Before they depart in September, the family groups join together to form flocks of 30 or more. These flocks often roost together in reedbeds or rough grassland, and you might find hundreds together.

Yellow wagtails migrate at night, leaving this country in flocks at dusk. Some 30 days and 4800km (3000 miles) later they reach their destination: tropical west Africa, just short of the equator. They average 160km (100 miles), or 4 hours' flying, each day.

Pest removers Both in Africa and in Britain and Ireland, yellow wagtails are almost entirely insectivorous, and this is why they do not stay here in winter. Usually they hunt on the ground, searching leaf surfaces or running nimbly after insects. If this fails, they fly upwards to catch their prey, and sometimes fly from a perch. They eat midges, aphids, beetles and flies, so they are certainly welcome summer visitors here.

The many races of yellow wagtails

Yellow wagtails are found right across Europe and Asia as far as Japan, and even in Alaska. In different parts of this vast area, local populations show slight variations in colouring. Their summer plumage, on the head and throat in particular, shows different patterns and stripes of yellow, grey, black and blue. Our common race of yellow wagtails has a yellow head with a brighter yellow eye-stripe, but there are some blue-headed yellow wagtails (right) that breed in southern England. These belong to the race common in Continental western Europe.

male of blue-headed race

Top: At first the nestlings are naked and have to be brooded, but they soon grow a coat of long buff-coloured down to keep them warm. They are also blind for the first three days, but instinctively reach up for food when a parent lands on the nest. Soon they need feeding every 10 minutes. Although the young wagtails cannot fly until they are 16 days old, most leave the nest after about 12 or 13 days and hide among the vegetation.

Left: The nest is always situated close to water–whether a river, a lake or the sea. Here a yellow wagtail dries its plumage after a bath.

A WALK ALONG THE RIVER ROE

Roe Valley Country Park in Northern Ireland, with its wild beauty, its legends, history and wildlife, is a rewarding haunt at all seasons of the year. A walk through its woods and by the river reveals a host of rich and varied animals and plants.

Above: A view along the River Roe—the 'red' river. In times gone by the river attracted men who built mills and cut water courses to drive great wooden water wheels for grinding corn and processing flax. The men also cut down trees to provide space to bleach their strips of linen. But today only the racing, rushing River Roe is the same; the mill races are overgrown and heavy with still water, and along the edges of the river are silent, empty buildings.

The River Roe—the 'red' river—is born on the cold slopes of the Sperrin Mountains, fills with peaty water from heather covered hills and gathers enough strength on the journey to cut its way deep into a gleaming gorge of mica schist, before slowing down in sight of the sea and then slipping quietly away into Lough Foyle. It falls 30ft for every mile of its 39-mile course and, down the centuries, has carved out of the rock the Roe Valley Country Park in County Derry, the finest country park in the whole of Ireland.

The walk In September 1976 the Visitors Centre was opened in the Park and filled with displays illustrating the life and times of the Roe Valley. There is also a café and information room on the site. Your walk through the Park begins at this Centre.

Even as you leave the Centre to start the walk you are in the midst of the mills and machinery that once made the valley a hive of activity. And framed by an arch in the Largy Bridge is the legendary Dogleap, where a faithful hound of an O'Cahan jumped across the river and brought help from the Castle at Dungiven, a feat impossible for a mere modern hound.

After passing the Dogleap, take the pleasant woodland and riverside path in the deep gorge down to O'Cahan's Rock. The path follows the river for a mile or more, sometimes rising to the rim of the valley and sometimes skirting the edge of the river where your face will be wet with spray, then return by the new bridge at O'Cahan's Rock. Here, where a horse and its legendary rider leapt across the wide river, you can still see the mark of a hoof in the rock.

Down the centuries this fine river has gouged out a great gorge, exposing laddered sections of rocks deposited in past ages. These rocks range from recent glacial gravel deposits, through red triassic and carboniferous sandstones, to the Dalriadan mica schist. If you listen to the river you can hear that it is still cutting its way deeper by the rumbling sound of great boulders in potholes on the river bed. It is, perhaps, not surprising that the energy of the river was harnessed by men

for centuries, not only to drive the great water wheels of the mills but, towards the end of the 19th century, to generate electricity in the turbines of a power house sited close to the bridge, one of the earliest hydro-electric generating stations in Ireland.

Plants in the Valley The woodland trees lining this lovely gorge date from the late 17th century. Undoubtedly this area was originally a natural association of broad-leaved trees, but through time, denudation and clearance of the land during the Ulster Plantation by the London Companies for fuel, timber, linen and agriculture, the present, rather different, woodland association has grown. It is partly the result of regeneration, but also of the planting of hardwoods by landowners as people became established in the area. Today the woodland consists of oak, ash and holly, with introduced beech, sweet chestnut and sycamore, and a fringe of softwoods such as Scots pine, larch and specimen trees of silver fir, Douglas fir and Sitka spruce. The area is free of rhododendron and laurel, plants regarded by some as the scourges of planted woodlands.

Because of the damp conditions, the Park is rich in bryophytes. Along the Wet Walk some eight species of ferns flourish, including the lovely lady fern and the hart's tongue fern and, on moss-covered branches of old oak trees stretching out over the river, jungles of polypody ferns. In season, too, there is a rich crop of fungi–red agaric, puff-ball and many more, including the poisonous death cap and destroying angel.

Before the canopy of new spring leaves shuts out the sun, such plants as lesser celandine, wood anemone and wood sorrel flourish and set seed, followed by those with some tolerance of shade–bluebell, red campion and the beautiful enchanter's nightshade, which covers the floor of the woodland like a spell.

Other species have a more protracted flowering period, the various violets for instance, which have several blooming per-

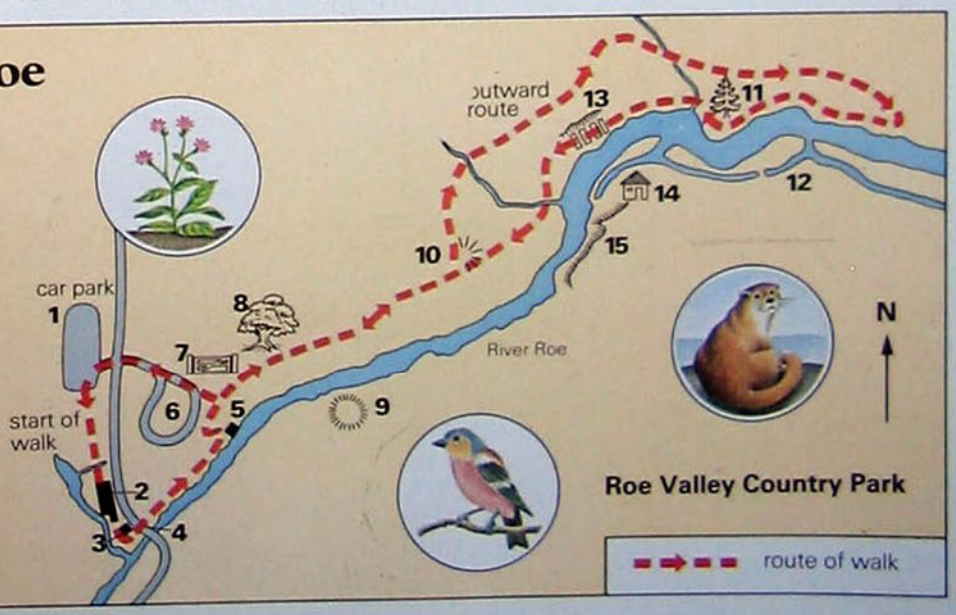
Above: The painted lady is one of the many butterflies to be found in the Roe Valley Country Park. One of the most interesting is the speckled wood; it is one of the few species which is more common in Ireland than in Britain, where it has a lower density and is more thinly spread. There is the usual selection of whites, and of vanessids such as the red admiral and the fritillaries, although the silver-washed fritillary is rare in the Park in spite of being common just a few miles away.

Left: Navelwort, also known as wall pennywort, can be found clinging to rocks and walls throughout the Park. It is named for its round, dimpled leaves.

Following the River Roe

The Roe Valley combines both historical and wildlife interest.

1 Car Park.
2 Dogleap Centre.
3 Power House.
4 Largy Bridge.
5 Corn Mill.
6 Caravan Site.
7 Traditional Gate.
8 Great Tree.
9 Site of O'Cahan's Castle.
10 Lookout point.
11 Larch trees.
12 Sir Thomas Phillip's lade.
13 Boardwalk.
14 Summer House.
15 O'Cahan's Rock.

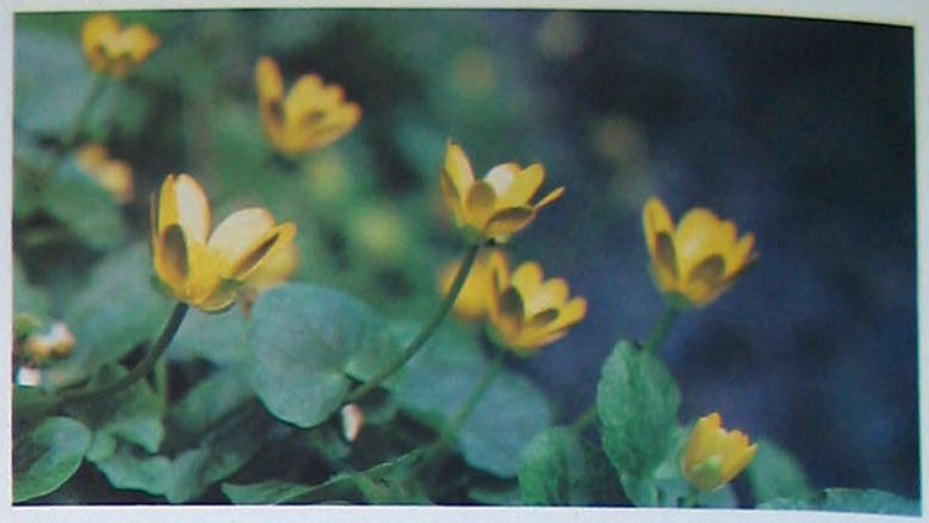


iods throughout the year, and self-heal and bugle, together with such plants as the superb woodruff, which is an indicator of the long continuity of woodland in the flora.

There is also toothwort, saprophytic on birch and abundant in some years, while aquatic species like water avens and marsh marigold flourish in the old mill races. Orchids are plentiful in the proper season, though there is no species which is of exceptional merit. There are good spikes of early purple and spotted orchids, with an abundance in some seasons of the bird's-nest orchid. Introduced species, like the monkey flower and balsam, grow along the edge of the river in quiet spots, and the North American fringe cup was first reported in the Park about five years ago; it has become abundant with the help of the flooding river.

Bird bounty Roe Valley has a variety of species of woodland birds, including jays, tits and magpies, but notable absentees are the nuthatch and the woodpeckers. A survey carried out in spring between Dogleap and O'Cahan's Rock, a distance of about a mile, showed that the most prevalent species was the chaffinch, which occupied 26 territories, followed by the robin (more abundant in Irish woodland than in British), with 23 pairs, followed by 20 pairs of blackbirds. Other passerines, such as the wren, various tits and the tree creeper, appeared in descending order of numbers, with one pair each of dipper and grey wagtail at the water's edge. In the tall tree canopy, sparrow hawks, wood pigeons and magpies were found to be the commonest species.

The winter population of birds frequenting the Roe Valley is enhanced by berry feeders such as the redwing and fieldfare, and seed eaters such as the siskin, bullfinch and greenfinch; and a visit at this time of year is often made memorable by the sight of a troupe of tiny pink, white and black long-tailed tits.



Above: In the damp woodlands of the Park such species as the lesser celandine flourish. This species flowers early, before the woodland floor is shaded by the canopy of new spring leaves.

Right: Although it does not breed within the Park, you may well spot a hen harrier winging its way through the trees. This magnificent hawk hunts small mammals, reptiles and birds.

Below: You do not necessarily need good eyesight to find the stinkhorn fungus in the Roe Valley. The disgusting smell it gives out may well be the first sign you get of its presence. The smell is designed to attract flies which distribute the spores.

Mammals and other animals Ireland has a rather sparse fauna of mammals and many species present in Britain are missing, if not from Ireland, then from the Roe Valley.

However, three badger setts are sited high over the river, one of which is shared with a fox, which changes its abode frequently during the breeding season. Where the river slows down and the rock gives way to small sand-filled coves, you will find the prints of otter feet in the wet sand, and a spraint (dropping) or two. The otter prints sometimes last for weeks, until obscured by the pin-prick footprints of brown rats.

The first feral mink appeared in the Park in 1979, but instead of building up a viable population as was expected in this desirable habitat, it disappeared again without trace. Of the red squirrel little is known; although it occurs in woodland just a few miles away it has not yet been reported from the Roe Valley.

THE MEDICINAL POWER OF MINTS

In ancient times, members of the mint family were widely used to treat diseases, and as charms against the stings and bites of serpents! Today, modern medicine still relies on a number of mints as sources of various types of herbal drugs.

Above: Lavender (*Lavandula vera*) has never successfully established itself here in the wild, but it is widely cultivated for its fragrant flowers and aromatic foliage. A few drops of oil of English lavender, taken in milk, are used as a tonic and a nervine—a medicine to relieve nervous disorders. In medieval times, the strong scent of labiates such as lavender was used to ward off unpleasant smells which were thought to be a form of airborne disease.

Members of the mint family—known as labiates—have a long history as culinary plants, but they were probably more important originally for medicinal purposes. Many of them have long-established traditional uses, frequently bound up in superstition as much as with any real healing properties which they may have possessed. However, not all the labiates are merely historically quaint, ineffective herbs.

Most commercial drugs are now synthetically produced, but modern medicine still uses a number of labiates in a variety of herbal remedies. Some species, for example mints and lavender, are cultivated on a large scale or imported from Europe, Japan and America for use in the drug industry. Other species, such as black horehound, are collected in the wild.

The preparations derived from labiates are many and varied, depending on the plant used and the condition to be treated. Prescribed medicines, and those bought over the counter, frequently take the form of tablets, tinctures and fluid extracts. Teas and lotions are often prepared at home.

Essential oils The active ingredients in labiates are contained in essential oils produced by the numerous tiny glands that cover the whole plant. These oils are responsible for the characteristic scent of labiates and are often named after the plants from which they are derived, for example, oil of peppermint, oil of lavender, and oil of origanum (which in fact comes from thyme).

As the oils are volatile (they evaporate rapidly), a common method of extracting them is by distillation. Steam is passed over the herb and takes up any volatile products. It is then condensed and collected. Repetition of the process, and variations on it such as fractional distillation, yield very pure products.

This method of extracting essential oils was discovered by the Arabs before the 11th century and its practice reached a peak in Europe during the Middle Ages. Drug preparation then was largely covered by the rules of alchemy in which the aim was to

discover the *quinta essentia* or quintessence (the purest form) of a drug. The essential oils which are obtained from the crude or non-essential parts of the herb represented this quintessence and were highly esteemed.

Labiate oils frequently have both antiseptic and anaesthetic properties. Menthol, from oil of peppermint, and thymol, from oil of thyme, are used for these purposes. Thyme and sage leaves are used to make antiseptic gargles, while a few drops of oil of peppermint or oil of spearmint in a pint of water makes *aqua menthae*, which is used as a gripe water for babies. However, such distilled oils are concentrated and must be used with care as an overdose can be dangerous.

Above: Betony (*Stachys officinalis*), in flower from June to September, was once considered to be capable of curing anything. It was grown in monastery gardens for its medicinal properties and in churchyards to ward off evil.

Left: Gill tea was made from ground ivy (*Glechoma hederacea*), collected while in full bloom during March to May, and flavoured with honey and liquorice.

Below: A tea used to treat consumption and haemorrhages was made from bugle (*Ajuga reptans*), which flowers from May to July. Used medicinally, it is a mild narcotic, and acts in a similar way to digitalin, the powerful heart drug obtained from foxgloves.

Herbal drinks Distilled oils are also used as a basis for other preparations, such as cordials and tinctures. Oil of balm is the main constituent of Carmelite water, a cordial remedy for headaches and neuralgia, and toothache can be relieved by tinctures made from basil-thyme and oil of peppermint.

Tinctures are alcohol solutions of essential oils; old-fashioned tinctures used brandy or sometimes wine. A tincture of lavender, known as lavender drops, was used as a restorative for faintness, while 'palsy drops' were made from a complex preparation of lavender, rosemary, nutmeg and other spices distilled with brandy.

Perhaps the commonest method of taking herbal drugs is in the form of teas or tisanes. These are prepared by infusing the fresh or dried plant with boiling water for a few minutes. The usual measure is one ounce (28g) of the herb to a pint ($1\frac{3}{4}$ litres) of water, with honey or sugar added for sweetness and flavour. The dosage is variable and the tea can be taken cool or hot, depending on the treatment.

Most labiates can be taken as teas. Wall germander and wood sage tea, made from the whole plant collected in midsummer, are used as tonics. Black horehound, motherwort and hyssop teas all reduce blood pressure, although black horehound and motherwort taste rather unpleasant in this form and are usually taken as liquid extracts instead. Motherwort is also used as a sedative and forms an important constituent of proprietary cardiac restorative tablets. Betony tea is another sedative and also alleviates migraine, thyme tea is used to treat whooping cough, and balm tea with sugar and lemon cools fevers.

Liquid extracts An alternative to an infusion is a decoction or liquid extract. This is the liquor obtained by boiling the herb in water for some time. Either the fresh, green plant or dried herbs can be used and decoctions can be prepared from most labiates but some, such as pennyroyal, contain large quantities of essential oil and should never be boiled.

Although they are not so popular now,

decoctions were widely used up to this century. The liquor can be used externally or internally; decoctions of wood sage are used on bruises while ground pine, combined with other herbs, can be used to treat both asthma and gout. For internal use, the dose was measured in a wine glass and a widespread habit was to temper the taste of the decoction by ensuring that the glass already held some of its more usual contents. Whatever the effect of the decoction, no doubt the wine produced a measure of well-being!

Ointments, lotions and syrups At one time, members of the mint family were reputed to be ideal dressings for wounds, or for use in poultices. The woundworts, such as hedge woundwort and marsh woundwort, gained their name from their use in staunching the flow of blood and healing deep wounds. In common with thyme and mint, the essential oils of woundworts have antiseptic properties desirable in such dressings, and the juices of these plants are styptic (they help to prevent bleeding). The young tops of the plants can be dried, reduced to a powder and dusted on wounds and sores.

The dried leaves of various species also found their way into herbal tobaccos and snuffs. Betony and ground ivy were particularly popular. A tobacco made from betony, coltsfoot and eyebright brought relief from headaches, and betony was also a major constituent of a famous snuff, taken to alleviate head pains.

Some ointments and lotions made from labiates require the addition of various substances to produce the right consistency. Marjoram simmered with wax produces an ointment for rheumatism, while a combination of wood sage and chickweed yields a lotion for sore skin. An ointment made from the leaves of bugle, together with those of sanicle and scabious, pounded with hog's lard, was once regarded as a great cure-all.

Above: Seeds from wild clary (*Salvia verbenaca*), in flower from May to August, were used by early herbalists to treat eye irritations. The mucilaginous seeds were first placed in water, which they absorbed, swelling in size. When placed under the eyelid, the seed would ease the irritation and take any dust or grit with it when it was removed. Modern herbalists have dispensed with the seed, but still use the mucilage obtained from it for the same purpose.

Rather more tempting to the modern taste are the syrups made by pounding or infusing fresh leaves with sugar, or adding the fresh juice of the plant to an already prepared syrup. A syrup made from self-heal was used to treat internal bleeding. Syrups made from thyme, hyssop or white horehound soothe coughs and are especially suitable for children because of their pleasant taste.

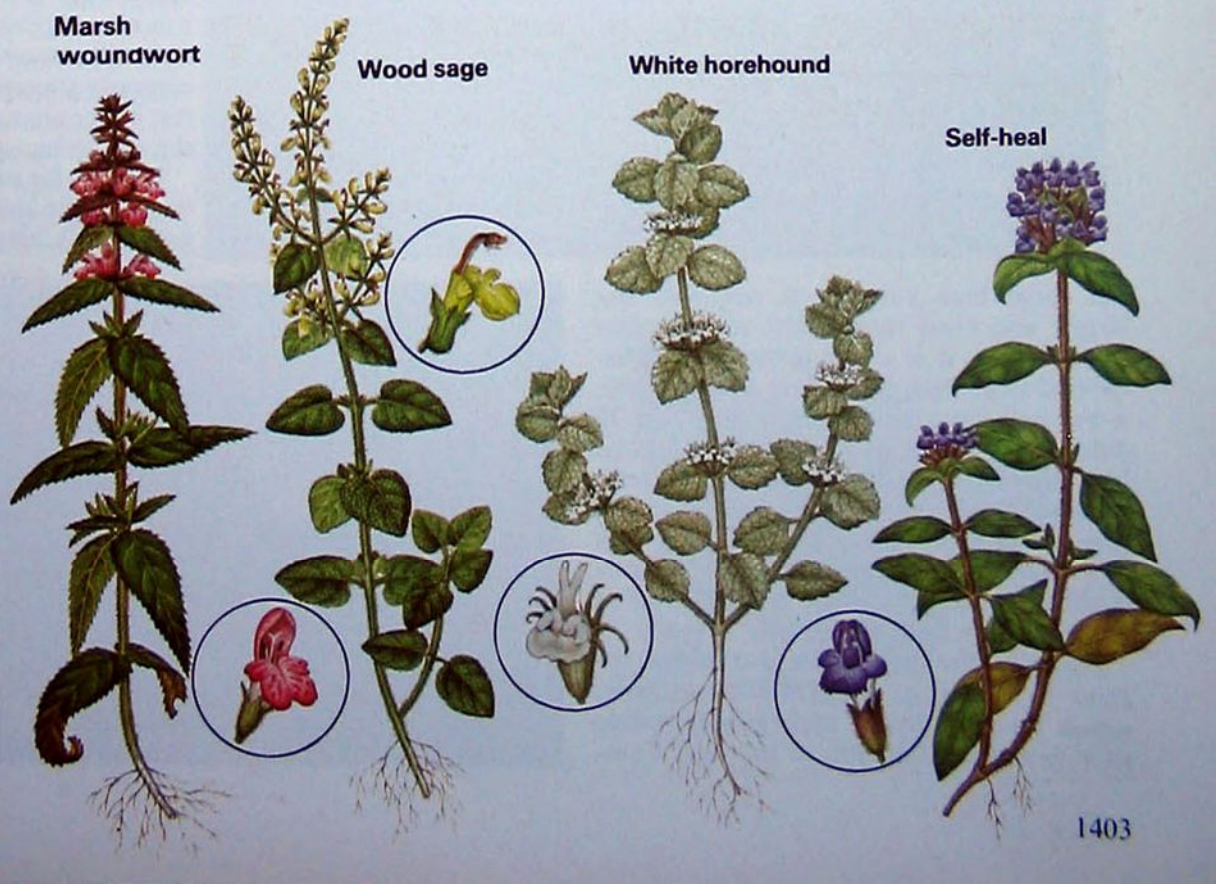
White horehound is still regarded as one of the best treatments for all breathing disorders. It is an ingredient in numerous over-the-counter remedies, and horehound candy can be bought or made at home. An old recipe advises boiling the fresh plant to extract the juice, then adding sugar and reboiling until thick. The candy is cooled and set in slabs.

Marsh woundwort (*Stachys palustris*). Flowers July to September in ditches, marshes and fens. Ht to 1m (39in).

Wood sage (*Teucrium scordonia*). Flowers July to September in dry woods, grassland, heaths and dunes. Ht to 30cm (12in).

White horehound (*Marrubium vulgare*). Flowers June to November on waste ground and downs. Ht to 60cm (24in).

Self-heal (*Prunella vulgaris*). Flowers June to September on waste ground and grassland. Ht to 30cm (12in).



THE LAST OF THE LARGE BLUE?

The extraordinary lifestyle of the large blue butterfly, which is inextricably linked with the red ant, has proved to be a major reason for its rarity.

Above: Male large blue butterflies spend most of their short lives patrolling their breeding areas, searching for mates. Any newly emerged female is soon found, and mating lasts for about an hour, often occurring on a tall grass stem. The rest of the female's short life is devoted to egg-laying.

Below: The young caterpillar closely resembles the pink flowerheads of the wild thyme plants on which it feeds.

The large blue butterfly is not only the largest and most magnificent of our eight British blues, it is also a great rarity. Discovered near Bath in the late 18th century, it has only been reliably recorded from 90 different sites, but its recent steady decline has caused great concern among conservationists. Many efforts have been made to save it but, sadly, they have all failed. It is now believed that the last British colony could have become extinct in 1979–the first loss of a native butterfly for over 50 years.

However, the large blue is also famous for another reason–its extraordinary lifestyle, which involves living underground inside ants' nests for 10 months of the year. Entomologists had always been mystified as to why this butterfly, alone among British species, consistently died in captivity. Some thought it might need extra food, other than the wild thyme flowers on which the young caterpillars feed. The strange truth was only discovered when, early this century, an independent researcher, T A Chapman, accidentally made the major break-through One spring, he encountered a full-grown caterpillar of the large blue while excavating ants' nests. Unfortunately he squashed it, but discovered that the dead caterpillar's gut contents consisted of fragments of ant grubs, on which the caterpillar had evidently fed. As a result of this discovery, young, semi-wild caterpillars were kept under constant supervision in a garden and the rest of their fascinating life-cycle was revealed.

Mating and egg-laying Adult large blues emerge from the chrysalis early in the morning in late June and July. They are quite conspicuous, but rarely occur in large numbers; few sites have supported more than 250 adults. The average adult lifespan is about five days, and the entire flying period of the colony lasts about three weeks.

The butterflies rarely venture from their small, secluded breeding areas, which are generally on warm hillsides. Mating occurs as soon as the female emerges and, if the weather is fine, egg-laying begins almost at once. Usually, most eggs are laid on the second day of her life, being placed singly among the largest flowerbuds of wild thyme.

The small white egg hatches after 7 to 10 days, and the young caterpillar immediately bores into a thyme flower. In a good breeding year, two or more eggs may be laid on the same flower and when this occurs, the young caterpillars become cannibalistic and attack each other until only one is left. This instinctive aggression actually benefits the large blue later on, because each ants' nest can only support one or two caterpillars. If too many are taken inside, they soon eat all the ant grubs and then starve to death.

Waiting for adoption The young caterpillar feeds on the thyme flowers for three weeks, until it is 2-3mm long. It then sheds its skin

Above: A caterpillar rearing up for 'adoption' by a red ant. Since the caterpillar is roughly the same size and about as hairy as an ant grub, the ant, presumably, is fooled into thinking it is one of its own brood that has escaped, and takes it back to its own nest.

and, at dusk the next evening, falls to the ground and waits under a leaf. This places it in exactly the spot where red ants forage, and at the time of day of their peak activity.

On a good site, the caterpillar is usually found within 30 minutes, and immediately starts to secrete a sweet fluid from a tiny gland near its rear end. This greatly excites the ant, which drinks the droplets and crawls over the caterpillar, patting the gland with its antennae. This 'milking' may last for one to four hours, during which time the caterpillar gradually acquires the scent of the ant's nest. Suddenly, it rears up on its hind legs, tucking its head under its body in an S-shape and causing several of its segments to expand like a balloon. The caterpillar now feels firm to the ant's touch, rather like one of its own grubs, and so the ant invariably picks up the hunched caterpillar in its jaws and runs with it to the nest, carrying it underground and placing it among the ant brood.

Inside the nest, the caterpillar starts to attack an ant grub and, after a long struggle, pierces the skin and eats the contents. It continues to feed until the winter, when it hibernates deep underground with the red ants and resumes feeding in the spring. Then, in May, it forms a chrysalis while still inside the nest. This, too, can produce a sugary secretion and the ants tend it lovingly for about four weeks. Finally, the adult butterfly emerges and crawls to the surface early one morning, while the ants are inactive. Once outside, it climbs up a grass stem and dries out its wings.

Large blue requirements With such a specialised life-cycle, it is little wonder that the large blue has become extinct now in Britain. Its existence is further complicated by the fact that to support a colony, a site must contain not only large numbers of red ant nests, but also over 1000 wild thyme plants. Today, very few meadow pastures are maintained as close-cropped turf. Instead, they are ploughed, seeded or fertilised, eliminating most wild flowers, including thyme. Several famous large blue sites have been destroyed in this way. Then, in the 1950s, dwindling numbers of wild rabbits meant the grass was not cropped in the remaining rougher sites, which became too overgrown to support the red ant nests.

Although any of the species of red ant may be fooled into adopting the caterpillars of the large blue, the caterpillars nearly always die in the nests of all except one species, *Myrmica sabuleti*. This species occurs in large numbers only in the very warmest places, such as south-facing grassland slopes, where the grass is cropped very short. If the grass grows to more than 2.5-5cm (1-2in) tall, the nests will not survive.

The numbers of *M. sabuleti* ants declined unnoticed on the overgrown sites and by the early 1970s only two colonies of the large blue were left. The importance of this species of ant to the large blue was not appreciated until the late 1970s, by which time it was tragically too late to save the last known butterfly colony.

Conservation of the sites of some former, now extinct, colonies of the large blue has led to the reappearance of large numbers of *M. sabuleti* ants, and it is planned to reintroduce the large blue to these sites from the Continent, although this may be delayed for a few years in the hope that an overlooked colony may still exist somewhere in Britain.

Above: Once the large blue caterpillar is safely ensconced in the ants' nest it starts to feed. Over the next few weeks, before hibernating for the winter, it may eat as many as 50 ant grubs, as well as eggs. It grows rapidly and soon dwarfs the ants, which are oblivious of the huge, grub-like parasite in their midst.

Right: Large blue butterfly (*Maculinea arion*), on thyme. Wingspan 3-4cm ($1\frac{1}{8}$-$1\frac{1}{2}$in).

FOUR-LEGGED SHEPHERDS

With a wisdom and stamina bred into it down the ages, the Border Collie dog is virtually an extension of the shepherd's arm, enabling him to gather sheep for breeding and health inspections and to drive and hold them steady for handling.

Above: The dog on the left, his tail up to balance him, is responding to the shepherd's command to 'flank to the left'. He is gathering the sheep that are straying up the hill. The dog below is walking to move the ewes on the right.

With the progress of veterinary techniques in agriculture, the shepherding of Britain's flocks of sheep has now become a science as well as a craft; yet take away the skill of the shepherd himself, and the biggest single factor in the successful farming of sheep is the working Border Collie dog. Without it sheep would be hard to manage.

Vast areas of the countryside are fit only for the grazing of sheep, and without the collie dog to herd and manage the animals the land would be impossible to farm. The working sheep dog is consequently an essential tool if the shepherd is to manage his flock. Supremely intelligent, utterly faithful, tireless in its desire to work, lissom and fast as the wind, the modern collie has earned a reputation as one of the world's wisest dogs.

Picking a pup Choosing a collie pup is not an easy task, even for the most experienced shepherd. There are three basic requirements, only two of which can be accurately determined. The shepherd will already know the breeding, the qualities of the sire and dam which have taken him to the litter in the first place; and he can check the general health of the pup, the growth of bone and its air of well-being; but the dog's temperament can only be assessed from that of its parents and, if available, their offspring of an earlier litter.

Mischievousness and personality are a good sign in a pup; so the one which comes to greet the shepherd when he visits the litter is more promising than the one which runs to its mother or cowers in a corner out of the way.

Initial appearances count for much with working collies, and some shepherds will never take a pup which does not immediately appeal to them. The set of the tail is important. A tail that is kept low shows control and good temper. It acts like a rudder, helping the collie to balance when he swings round. The colour of the coat also matters because a light-coloured or white-coated dog arouses the inquisitive instinct in sheep and makes them more stubborn and less easily managed. The coat should always be gleaming. A shepherd will look into the pup's mouth to check that the teeth are white, and that the smell of the breath and the colour of the tongue are good. The legs should be thick with strong bone, and the eyes should sparkle.

The pup to choose is one that has not only been bred for physical soundness, but also for intelligence and character, with a temperament that makes it pliable and tolerant of its master's shortcomings.

Training a collie 'The great qualities and powers of the sheepdog have been taught by dogs to shepherds, not by shepherds to dogs,' said Mark Hayton, the famous Yorkshire collie trainer. Nevertheless, it was, and still is, the breeder who, by knowing the nature of the collie dog, implants those shepherding qualities. To awaken them in a collie pup, to teach it how best to use them, is a satisfying and rewarding experience.

If a collie is schooled too fast and its temper is impaired, the relationship between dog and master is damaged and cannot later be mended. If a teacher pushes the physical side before the mental side is ready the natural balance and temperament of the collie disappear for good.

The puppy should be allowed to roam the farmyard whenever it is not likely to be in the way of operations, for experience of the ways of life is a lasting lesson, and its instinctive herding qualities will often be tested out on the fowls or farm cats around the yard. The pup must also be talked to as it grows up. It should be disciplined when it is naughty by picking it up by both ears, shaking it gently and speaking to it firmly. It must be judged for the development of its physical strength and intellect.

When the shepherd thinks the collie is sufficiently strong and mature to be responsible for its actions, usually around the age of nine months, it is introduced to sheep. Its reaction, self-confidence and initiative will soon show whether it is ready to begin the serious business of learning its craft. If so, patience and kindness, coupled with firmness, will teach it how to herd sheep with care and respect. It is the dog's superior intellect that establishes its authority over sheep and which, as the dog grows in stature, brings confidence and sympathetic understanding to a placid and unruffled relationship between dog and sheep – the ultimate in stock management.

There is another way to train a sheepdog. This is when the shepherd inflicts his dominant personality wholly upon the dog, divesting it of its own intelligence so that it dare not make a move unless it is instructed.

Television sheepdogs

The major sheepdog trials are governed by the International Sheepdog Society, which was formed in the year 1906 to 'stimulate public interest in the shepherd and his calling, and to procure the better management of stock by improving the sheepdog'. Televised trials are becoming more and more popular, and can now claim audiences of over eight million viewers!

Below: Wise and alert, Mel Bage's international champion Nell, and her daughter Fly, from Brechfa in South Wales. Nell and Fly are the proud winners of the 1980 Welsh National Brace Championships, where two sheepdogs are tested for their ability to work as a team together. Both dogs have what is known as a 'good box head': there is plenty of space between the ears and eyes for the brain. The dogs' wide nostrils enable them to breathe easily while they are running, and their eyes are gentle but firm, so that they can control sheep without terrorizing them. As you can see in the picture, Nell's ear is slightly damaged, but both dogs have a superb sense of hearing – essential when many of the commands they get from the shepherd come in the form of whistles or calls from long distances away. Nell is 11 years old and her daughter is 3 years old.

This is to 'break' a dog, a type of brain-washing that can start when the dog is very young, but the end product is not reliable and lacks initiative.

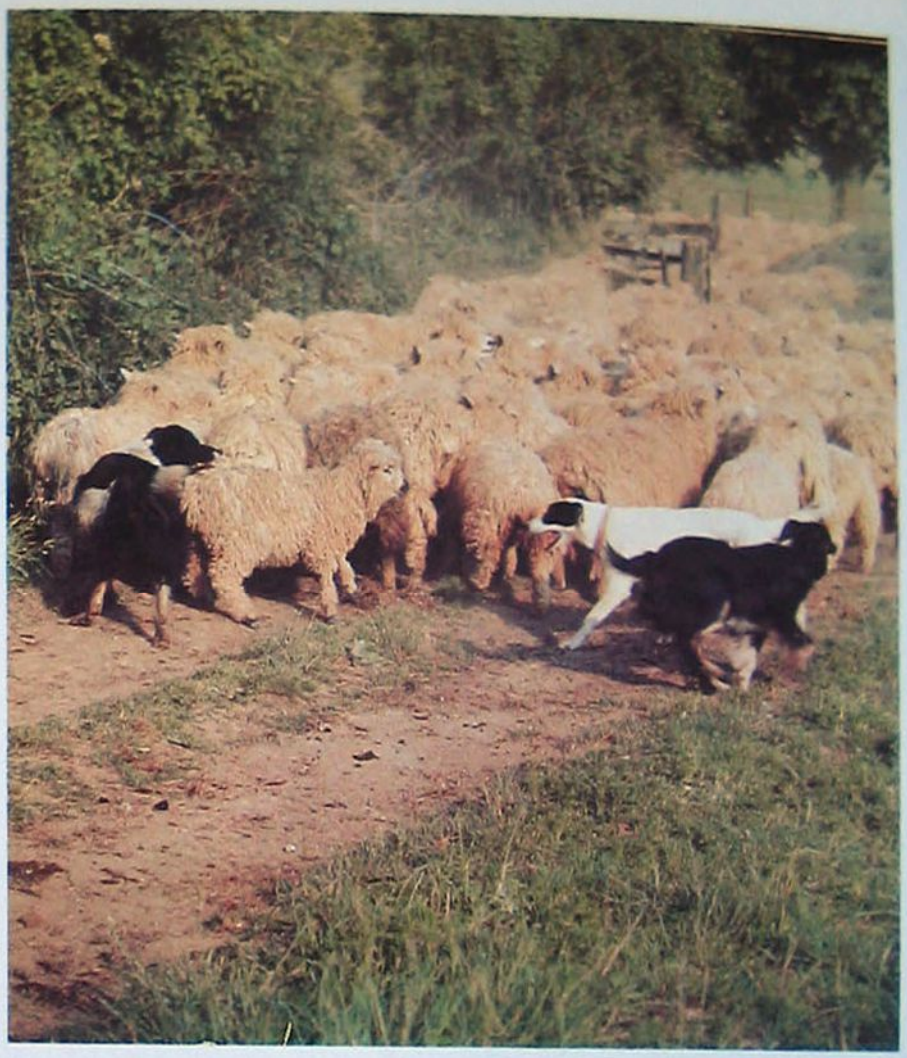
Sheepdog trials It is often said that all great dogs, like all great men, work not because they have to, but because they want to. This is certainly true of the modern collie whose total joy in life is to herd sheep. You can see how it delights in showing off its skills to the public at sheepdog trials.

Sheepdog trials were started at the end of the last century. The first were held at Bala, North Wales, in 1873, and they are now held wherever sheep are farmed. They provide a shop-window for collie craft, enabling the shepherd to assess the relative merits and failings of various families of dogs from which he can choose his breeding stock.

Apart from their appeal to the general public, sheepdog trials play a valuable practical role in the improvement of the working collie. A 'trials collie' is not a breed apart; it is simply a practical working collie whose master has taken time and trouble to polish it for the finer points of competition work, and trials encourage others to do the same to improve their dogs for work on the hillsides.

Sheepdog trials are based on a series of practical shepherding tasks designed to test the working ability of a dog in the management of livestock. The tasks form a continuing series of tests in gathering, controlling, bringing, driving, shedding, and penning sheep–into all of which is introduced the competitive element.

Evolution of the sheepdog No man can say with accuracy who taught the first dog the art of herding sheep. It has been a slow process of evolution until today the knowledge and desire to work is bred into the dogs. It was not always so. Records suggest that the dogs which ran with the sheep flocks of Job in the Old Testament days were lean and quarrelsome brutes, lacking initiative and loyalty. They were used mainly by shepherds to protect the sheep against wild predators, such as wolves and other vicious attackers, and human robbers and thieves.



Above: When several collies work with a flock of sheep, each dog responds to its own set of commands. Here one ewe on the left appears to be disputing the authority of the white dog. Shepherds are not keen on white-coated dogs because the sheep take time to get used to them, and often query their authority.

Below: A strong, fit collie is agile and easily able to outrun a field of sheep.

Their role was simply to guard the flocks of sheep and goats. Although they were ancestors of the modern collie, these dogs had none of the finesse and craft of today's sheepdogs. They were tough in a ponderous way, and their skill was in their strength and savagery, so that under the ancient Laws of Moses they were regarded as unclean animals, not worthy of mention.

Guardianship was the first service that dogs performed for the sheep farmer, and this is still their purpose in some parts of the world. There are over 50 types of stock-herding dogs in the world today, all descended from the ancient dogs of Biblical times, and each with its pastoral role to play; but the most versatile and intelligent is the British collie, which herds over one third of the world's sheep population.

The first record of Britons as farmers is around 330BC and it is fair to assume that whatever dogs were around then were there as stock guards. Their duties did not cease until sheep predators, such as wolves, disappeared from Britain, and for many centuries British sheepdogs were somewhat savage creatures of similar blood and inclination to those of mainland Europe.

By the mid-14th century sheep-keeping communities had spread from the south across England and Wales up to the Cheviot Hills and, dependent on the treatment they

received from their human masters as their role gradually turned to a more pastoral one, the dogs in these communities comprised numerous facilities with diverse capabilities and characteristics.

Breeding was a haphazard affair, with natural selection little better than in the wild, and it took over a century before a dog, smaller than the guard dog type, was capable of work that involved herding.

By Tudor times there are references in literature to sheepdogs that drove, rather than merely guarded sheep. The English sheepdog was described as 'not huge, vast and bigge, but of an indifferent stature and growth, because it hath not to deal with the bloodthyrsty wolf, since there be none in England'.

It has been claimed that Scotland was the place of origin of the Border Collie, traced from the years around 1600. It probably came to England during the great droving days of the 18th and 19th centuries.

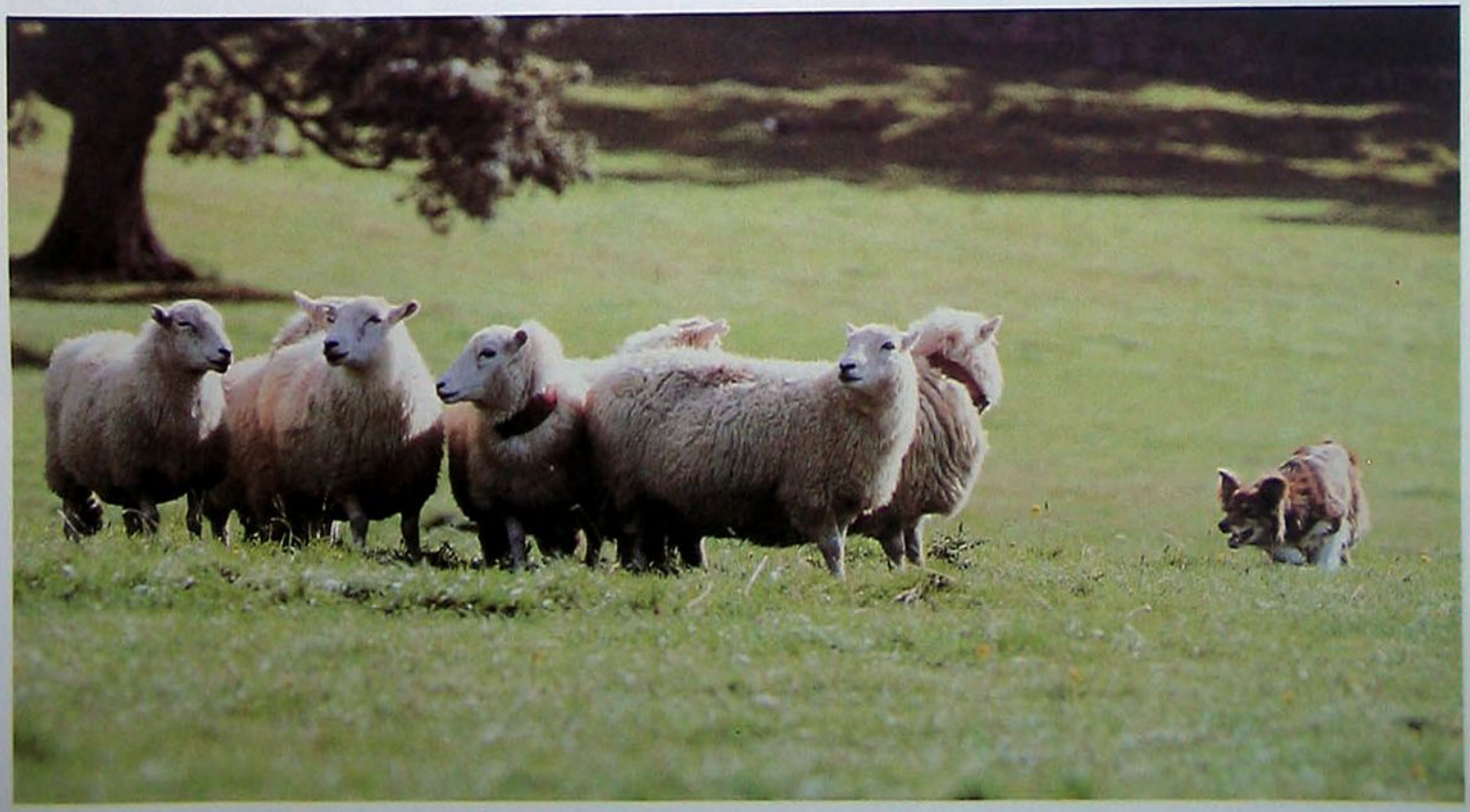
The Old English Sheepdog, of a slimmer stature than its present-day showring form, and the Bearded Collie, were at one time active in working sheep and no doubt had some part in the evolution of the modern working dog to a form much lighter and speedier than its ancestors to match the wiles of lively hill sheep.

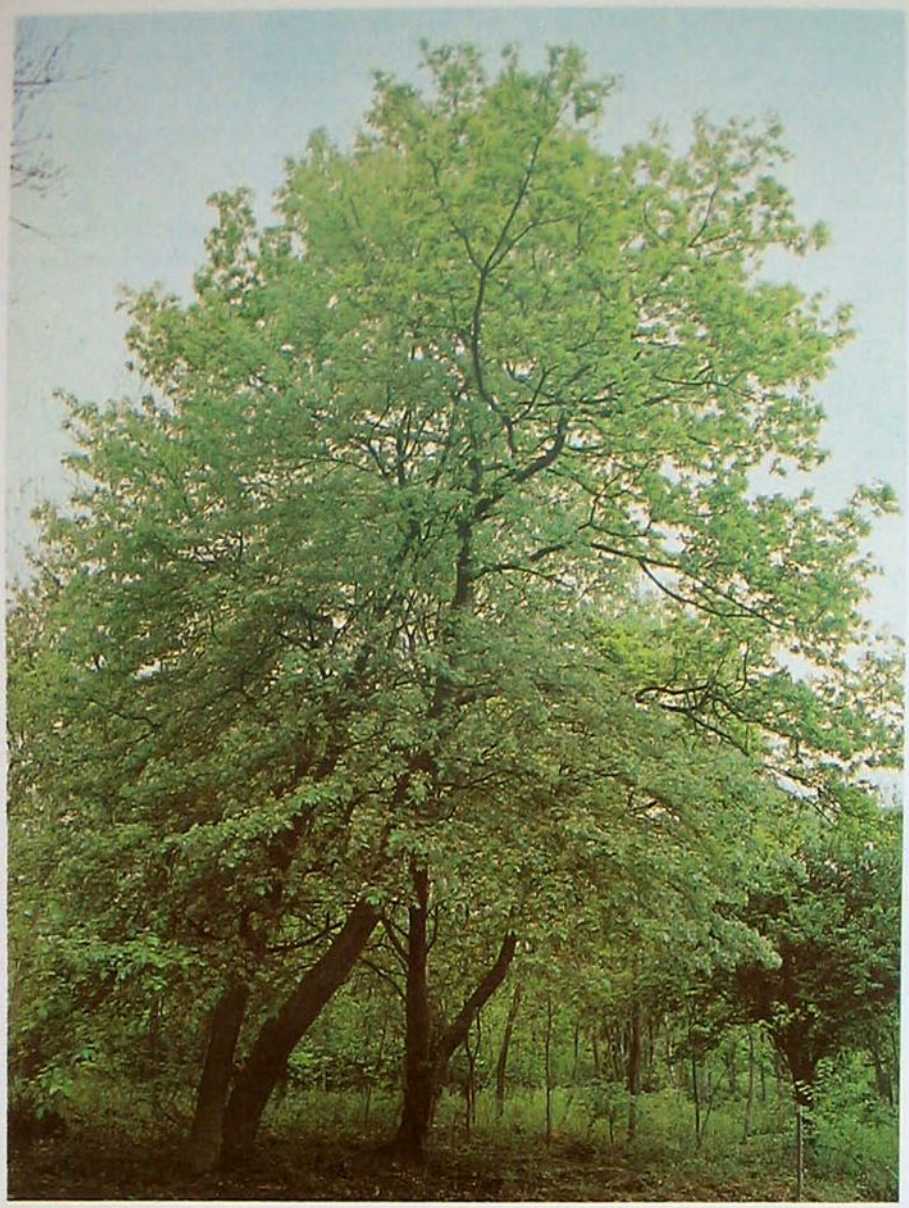
Old Hemp Undoubtedly the most important step towards the evolution of the modern Border Collie was the breeding of one dog, Old Hemp, in 1893 by a Northumbrian farmer, Adam Telfer. Hemp is today regarded as the foundation sire of the present highly skilled working dogs in Britain and the world. He set up what might be called a distinct family within the sheepdog world, with characteristics so strong that in time it enveloped most of the rest.

So far no one has been able to invent a mechanical replacement for the shepherd's dog, and the value of the working sheepdog to the sheep farming industry is inestimable. In the British Isles over 28 million sheep produce around £280 million worth of mutton and lamb, and 50 million kg (110 million pounds weight) of wool each year. Multiply the figure some 40 times to reach the world's sheep population of over 1,000 million, and you can see the importance of the sheepdog's role in the farming economy. It also plays a great part in the herding of other stock, for it is rare to find a stock-farm without its attendant collie.

Bottom: Another television star, Arthur Mawhinney's 'red' and white coated Cindy moves up to take control of Welsh mountain sheep.

Below: 'Steady, lass!': Cheviot shepherd Geoffrey Billingham orders his dog Jed to ease up, yet the collie's concentration on the sheep does not flicker. The herding instinct in collies originates from the hunting instinct—hence the collie's feline attitude as she controls the sheep.





THE RARE WILD SERVICE TREE

Britain's broad-leaved woods are dominated by a few familiar species, such as the oak, beech and birch. But scattered among these are some rare and little-known trees, including the oddly named wild service tree–a species once widespread in this country.

Above: In woodland, wild services usually remain small trees, though in an open glade they can reach a good height.

Wild service tree (*Sorbus torminalis*). Rare native deciduous tree. Found in woodland of south-east England. Height 27m (90ft).

The wild service tree is one of the few trees that are native to Britain. It is closely related to two other native trees, the whitebeam and the rowan, all being members of the same genus, *Sorbus*. Yet, while these two are both common and familiar trees, the service tree is now a rare tree in the wild.

Declining numbers There is good evidence to suggest that, up to the end of the Middle Ages, the wild service was abundant in many woods in southern England. Since then, however, its numbers have been steadily declining. This is partly due to forests being cleared to make way for agriculture. At the same time man has interfered increasingly with the remaining woodland so that, whenever a wood was cleared and then replanted, the wild service was unlikely to be given a place in the new plantations since it was not a particularly useful species.

You may wonder how similarly 'useless' trees like birch, holly and hawthorn have managed to survive. After all, they too are unlikely to have been planted in woods by man, yet they are still common enough there. The difference lies in the fact that, while most trees spread themselves easily by seed, the wild service tree lacks this ability. It produces large quantities of berries, yet very few of its seeds germinate to produce young trees. The reason for this failure is not known for certain but it may well be due to our climate. Perhaps, at some time in our past when our summers were warmer and our winters colder, the wild service was well adapted to the environment here. But the generally cool damp summers and mild wet winters of today seem to inhibit the production of viable wild service seed.

Where to see them The inability of the wild service tree to spread by seed means that it can now be seen only in old undisturbed woodland. Here, its main method of spreading is to send up sucker shoots from its roots a little distance from the main trunk. It therefore tends to occur in small groups.

The best places to see a wild service tree today are in the Weald of Kent, Sussex and Surrey, and also in south Essex. Elsewhere, it is thinly scattered through southern and south-west England, parts of the Midlands and south Wales. In northern England it is very rare, in Scotland almost totally absent and in Ireland entirely so.

Despite its present rarity, the wild service tree grows on a wild range of soils, which partly explains why it was so common in the days when our woodland was untouched. In south-east England it flourishes on clay soils, some of which are quite acid, as in south

Essex. Similarly, in south-west Wales it grows on acid soils in humus-rich valley bottoms. Yet in the Bristol area and the lower Wye valley it is found on rocky limestone woods, even rooting itself in crevices on limestone cliffs.

Handsome and shapely Most specimens of the wild service are small trees between 5m (16ft) and 12m (40ft) in height. But a few grow to be much taller – up to 27m (90ft) high with a girth of 3m (10ft). Such fine specimens are rare today but were presumably commonplace in our woodlands long ago.

When it has room to spread fully, as it does in a glade, the service develops a wide crown and long lower branches, making a handsome and shapely tree.

Its bark is a dark grey-brown, sometimes reddish-brown, and flaky with shallow vertical and horizontal fissures.

Leaves, flowers and fruits Like all other members of the genus *Sorbus*, the wild service is a deciduous tree. The leaves are borne alternately on the twigs and are about 10cm (4in) long. They can be distinguished from the leaves of other *Sorbus* species by their deeply lobed, maple-like shape. Their upper surfaces are glossy dark green and their lower surfaces are a paler shining green; the young leaves are slightly downy underneath. In common with the leaves of other *Sorbus* trees, the margins are finely toothed.

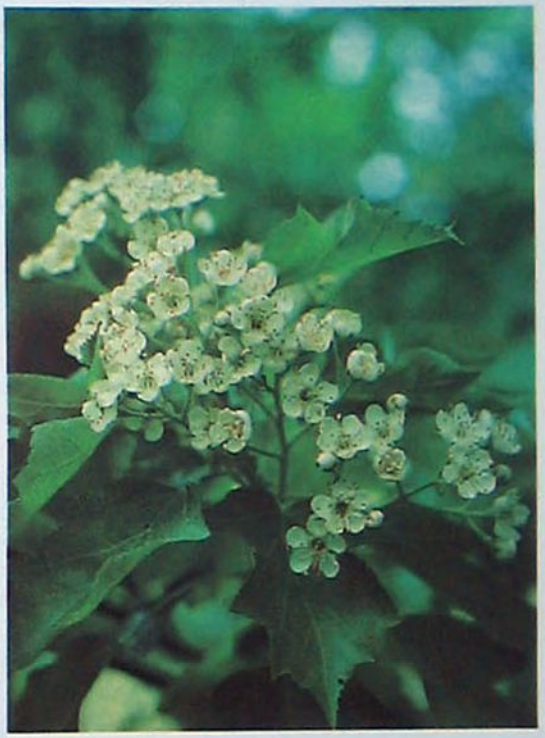
In late May or early June, the wild service bears clusters of white flowers, resembling a loose-headed spray of hawthorn, except that the flowers on the wild service are fewer and larger.

In autumn, the flowers are followed by clusters of round or pear-shaped brown berries covered with pale spots called lenticels. At this time of year, the leaves turn bright yellow, red or orange.

Uses for wood and berries The wild service tree is so rare today that its wood is seldom used. However, being a slow-growing, long-lived tree, its timber is very hard and close-grained, and was once employed for making cog wheels.

The berries of wild service were once a popular food source. In the days when sweeter, foreign fruits were not readily available, the berries were sold in markets throughout southern England. Their main uses were for making into jams and marmalades, and possibly also into alcoholic drinks. They have a bitter taste, however, and before being eaten raw they need to be 'bletted', that is, allowed to become half-rotten.

Why 'service'? The word 'service' is a corruption of the Latin word 'sorbus'. In south-east England it is more commonly known as the chequer tree. The reason for this name is obscure, but it may be a reference to the spots on the berries or to the bark splitting into squares. Being a native tree there are many other local names for it, including 'serves', 'lizzory' and 'lessory'.



Above: In the autumn, wild service trees are bedecked with clusters of brown spotted berries. In the days before sweeter, foreign fruits were readily available, wild service berries were sold in the markets of southern England to be made into jams or eaten raw.

Right: Wild service trees flower in late May or early June, small white five-petalled flowers appearing in loose flowerheads at the ends of twigs.

Below: In parts of south-east England, the wild service is known as the chequer tree, a name that may derive from the fact that the bark in older trees often splits into small squares.

BACK TO THE LAND

Most crustaceans are marine creatures but two members of this huge group – hoppers and sea slaters – have returned to the shore to lead a completely terrestrial existence.

A surprising number of marine animals have partly forsaken the sea to lead a semi-terrestrial life on the intertidal region of the shore, in spite of the rigorous conditions encountered there. However, the part of the shore beyond the highest tides has been colonized by a very limited number of marine species – one of the few examples being the land crabs of tropical beaches. But even these have to return to the water to breed.

Just a handful of shore-dwelling animals can claim to be totally independent of the sea throughout their lives – on British coasts they are represented by sea slaters and hoppers.

Sea slater World-wide there are many species of sea slaters, but only one, *Ligia oceanica*, inhabits British coasts. The sea slater is a crustacean and bears a close resemblance to the woodlouse, to which it is closely related. It has a flat, greenish-brown segmented body, with thin antennae projecting from its head and a pair of 'tail forks' from its rear. Each segment is equipped with a pair of slender legs that allows the slater to run with great agility.

The best places to find sea slaters are among seaweed-covered shingle along the high shore or in the crevices of quays and breakwaters – the slaters' flattened bodies allow them to slip into very narrow crevices.

Slaters are occasionally seen moving around during daylight, but they are primarily nocturnal. If you visit the shore at dusk, torchlight will reveal large numbers crawling over rocks, though they will quickly scurry away to hide from the light. Large numbers of slaters often follow a receding tide at night, moving down the shore to feed on bits of seaweed and other organic debris.

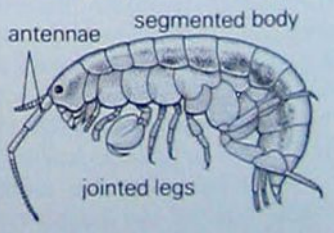
Terrestrial life-cycle The slater's independence from the sea is reflected in its breeding habits. The female carries her developing eggs around with her, in a special 'brood pouch' formed from overlapping plates beneath the body. The young undergo almost complete development inside this pouch and when they emerge they resemble miniature adults; each brood contains on average 80 young.

Growth is accomplished by moulting: since the slater's hard skin cannot expand to accommodate its growing body it has to be shed and a new one grown. After moulting, the slater is highly vulnerable since it initially lacks its hard skin and can walk only with difficulty. During this period (12 hours or more) it remains hidden. Studies have shown

Above: Only one species of sea slater, *Ligia oceanica*, is found on the coasts of Britain. It grows to a length of 2.5cm (1in) and has a flattened segmented body. Notice the pair of antennae protruding from its head and the two 'fork tails' from its rear.

Opposite left: Slaters usually hide in the crevices of quays and breakwaters or among seaweed-covered shingle. The best time to see them is at night when they come out to feed.

Anatomy of a hopper



Above: One of the most common British hoppers, *Orchestria gammarellus*. All hoppers have a hard segmented body with a pair of antennae and several pairs of long jointed legs.

that most slaters moult when the tidal range is at a minimum, presumably to reduce the possibility of being drowned at high tide.

During the first year of its life, the young sea slater grows rapidly and becomes mature during its second year, when it begins to breed. Females produce two broods in this second year and three the following year. In Britain, sea slaters do not usually survive longer than three years.

Hoppers on the shore The other marine animals which have returned to the land around our coasts are the hoppers. The two most common species of British hopper are *Talitrus saltator* and *Orchestia gammarellus*, both known as sand hoppers. The former is often found among decaying seaweed washed up along the high tide mark of the shore. The latter species can be found in the same habitat and even some distance inland if the ground is damp.

Like sea slaters, hoppers are mainly nocturnal creatures, emerging at dusk to feed. They differ in having segmented bodies that are compressed from side to side instead of from top to bottom, and in their remarkable ability to jump (hence their common name). The jumping is performed by rapidly straightening their normally curled bodies. When hoppers land, the impact is absorbed by their specially developed back legs.

The purpose of jumping is to search for food. The direction in which hoppers jump is not as random as might be thought, for research has shown that they usually jump towards the sea. During the day, they use the sun to orientate themselves, and at night the moon. Some species, however, seem to use some other, unknown method of direction-finding.

The life-cycle of hoppers is very similar to that of sea slaters. The females carry their developing young in a pouch; when liberated the young are similar in shape to their parents and grow by moulting.

Above: A hopper, *Talitrus saltator*, making a rare daytime excursion. Hoppers are a little smaller than slaters and quite different in shape, having bodies that are compressed from side to side.

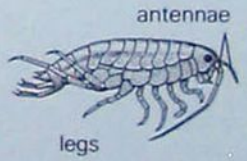
Invaders of the home Dwellings near the coast are sometimes invaded by hoppers. Such incursions are usually only short-lived but may occasionally reach plague proportions. No satisfactory explanation has yet been given for this behaviour. Exceptionally high tides may force hoppers to abandon their normal living places on the shore and move inland. Alternatively, a sudden rise in the hopper population may trigger off a migration inshore. In either case, the hoppers will enter any building that lies in their path.

Occasionally hoppers can invade buildings far from the sea. This occurs when large numbers of them are unintentionally transported inland among seaweed used for fertilising fields. From there, they invade local buildings.

Colonizing the land Slaters and hoppers are among the few marine animals that have successfully adapted to a truly terrestrial life. Yet, there is nothing new about this process: after all, the land was first colonized by creatures from the sea. But this colonization is generally thought to have occurred via freshwater habitats. Slaters and hoppers, however, have made this transition straight from the sea.

Woodland hopper

One species of hopper to be found in Britain lives in leaf-litter, often many miles from the sea. It is known as the woodland hopper (*Talitroides dorrieni*). This species is not native to Britain; it was first discovered in the Botanic Gardens on Tresco in the Scilly Isles, where it had been accidentally introduced along with specimens of plants and other animals from New Zealand. The woodland hopper is also known to exist in Galway and is now well established around the Lizard peninsula in Cornwall, where it seems to be extending its range. In appearance, it is very similar to sand hoppers.



Left: Sea slaters are usually greenish-brown but they may sometimes be seen in other colours. This specimen is a mottled blue-grey and white in a successful attempt to camouflage itself against a rocky background.

Yellowhammer (*Emberiza citrina*); resident farmland bird, with yellow plumage, especially on head of male; 17cm (6½in).

Left: A male yellowhammer sits on a typical songpost. You can often hear the yellowhammer's jingling territorial song from late February to August or even September. Traditionally this familiar sound is verbalised as 'a-little-bit-of-bread-and-no-cheese'. A more accurate version might be 'chi-chi-chi-chi-chi-chi-chi-chi-chee'. At breeding time, his song warns other males where his territory is.

HANDSOME BUNTINGS

Two of our smartest buntings are the yellowhammer and the cirl bunting. The yellowhammer is well suited to our climate, but the cirl bunting is really a Mediterranean species.

Buntings are slender songbirds that look similar to finches, with the same stocky seed-eating bills. However, they generally prefer more open country, feed mainly on the ground and have less musical or varied songs than finches. In all except the corn bunting, the male is brightly coloured – male yellowhammers and cirl buntings are particularly attractive – but females and young birds are drab and inconspicuous.

Vivid yellow The male yellowhammer is yellower than all other British birds except the yellow wagtail, and in summer his head is almost totally bright lemon yellow. His underside is also yellow, but with a brownish breast-band and a few brown streaks on the flanks. His upperparts are chestnut, and attractively marked with black and brown except for the rump, which is plain. The outer tail feathers are mostly white.

All yellowhammers, whatever their age or sex, have a chestnut-coloured rump – an important distinguishing mark. Young birds and females are much less yellow than males, particularly on the head. They are more heavily streaked and, apart from the rump, are easily confused with cirl buntings.

Active farmland life Yellowhammers are familiar farmland birds; in winter you find them feeding on stubble fields and ploughed land, mingling freely with larks and finches. Often the male's yellow head is the first thing

Below: Yellowhammers make their nests out of grass and a little moss, and line them with hair, fine grass and roots. Most choose a site within a couple of feet of the ground. Many actually nest on the ground, hidden among grass and other low plants. Some lay eggs as early as mid-April, but most start in May. The eggs are whitish or pinkish, with fine, irregular dark brown squiggles and a blotch or two.

you see as he hops along in a low, crouched position. They often flock together at feeding places, and if disturbed fly into nearby trees for safety. In flight, yellowhammers have noticeably long, white-edged tails and a slightly bounding action. Often they call as they pass over–a sharp 'chip' or 'chillip'. Another characteristic call is a low 'dzee'.

They eat mainly seeds, especially leftover corn and the seeds of grass and weeds. They also eat wild fruits such as blackberries and, in summer, insect larvae, beetles, spiders, millipedes, and even slugs and earthworms.

Mixed habitat Yellowhammers nest in almost any country area. Ideally they need open ground for feeding, low scrub for nesting and taller bushes or trees as song-posts. Their favourite habitat is the edge of a young conifer plantation where brambles and other plants are still common; here they reach densities of up to 58 pairs in a square kilometre (150 per square mile). Most of our farmland has an excess of open ground and a shortage of scrub and song-posts, but fields bordered by hedges with some tall trees are nevertheless quite suitable. Heaths and commons with clumps of hawthorn bushes have always been good yellowhammer sites, but in recent years the birds have spread into woodland.

During the cold winter of 1962-63, the whole yellowhammer population was severely reduced, but since then it has recovered well and there are signs that it was relatively unharmed by the cold snap in January 1982. Each year, the best breeding sites are occupied very early in spring, and late arrivals occupy whatever sites they can. However, now that the population is large again, farmland has become overcrowded, leading to an overspill into woodland rides and edges. Normally yellowhammers ignore these far-from-ideal sites, but since the only alternative is a tiny patch of farmland already filled to capacity, they have little choice.

Bird of many names In the past, the yellowhammer has been known by over 20 different names. Its bright plumage is mentioned in many of these. In Scotland, its local names

Above: Yellowhammers are widely distributed in Britain and Ireland, while cirl buntings are limited to southern England. Most birds of both species rarely travel more than a few miles in their lifetime.

Above: left: There are five buntings that nest in Britain and Ireland, the most common and colourful being the yellowhammer. The cirl (pronounced serl) bunting has a very similar plumage but is quite rare. Two of the other species are common: the corn bunting–most frequent around cornfields–and the reed bunting, which favours wetlands. The snow bunting is a very rare British breeder; only a handful of pairs nest on mountains in Scotland, though many more visit us in winter.

Right: A female yellowhammer at her nest. The usual clutch is three or four eggs, but clutches tend to be smaller in conditions of overcrowding, in poor habitats, in northerly areas or very early or late in the breeding season; this is likely to be because there is not sufficient food for the parents to cope with large broods in these circumstances. As laying can continue until August, each pair has time for three successive broods, but egg-stealing magpies limit some to only two. Incubation takes 12-14 days and is largely the responsibility of the female, who is far better camouflaged than the male. The young fly at 12-13 days.

Above: The easiest way to find a cirl bunting is to listen for the male's rather simple, monotonous song. It sounds like a hurried yellowhammer's song (without the 'cheese'), but it can be hard to judge because yellowhammers themselves sometimes do not complete their song. The song is also often compared to the final rattle of the song of the lesser whitethroat – a warbler which sometimes nests close by. The cirl bunting's usual call is a weak, squeaky 'seep'.

Cirl bunting (*Emberiza cirlus*); resident in farmland in southern England; not unlike the yellowhammer but with black chin and eye-stripe, and olive colour on rump. 17cm (6½in).

include yellow bunting, yellow yorling, yellow yite and yellow yoit; and in some English counties it is known as the yellow amber, yellow yowlie and yellow ring. The lines on its eggs give rise to names such as writing master, scribbling or writing lark, scribblie and scribbler.

Cirl buntings These birds are stockier and slightly shorter-tailed than yellowhammers, but have very similar habits. Their food seems to be similar and you may see both species feeding together. Pairs are usually widely scattered, so that although family groups stay together in autumn and winter, they do not form large flocks.

An adult male cirl bunting is a handsome bird with very distinctive head pattern (although, as with the yellowhammer, breeding colours are subdued in winter). He has a black chin, a yellow-bordered black eye-stripe and a greyish streaked crown. Across the breast is a greyish-green band, and the flanks are chestnut coloured. The rest of the underparts, the tail and the back are similar to those of the yellowhammer except for the rump, which is an inconspicuous olive colour and not chestnut.

As with yellowhammers, female and young cirl buntings are less distinctive, browner and more heavily streaked, but they still have the tell-tale olive-coloured rump. They lack the male's head markings, although the female has faint yellow stripes above and below the eye.

The song period, breeding season and choice of nest site are similar to those of the yellowhammer. Sometimes the cirl bunting nests in a large garden on the edge of a village, in which case the male may sing from a roof top or television aerial. The female both builds the nest and incubates the eggs, but is fed by her mate at this time. Even when she is feeding nestlings, he gives the food to her and she distributes it.

A more southern species England is currently the most northerly outpost of the cirl bunting; they were first discovered breeding in Devon in 1800. A century later they were common throughout England and Wales, and some bred as far north as Cumberland and Yorkshire. However, since then their range has contracted dramatically, and none now nest north of Worcestershire. At their peak, cirl buntings were more common than yellowhammers, but now you are lucky to find any – only 500 pairs are thought to survive here, compared with one million pairs of yellowhammers.

The cirl bunting is mainly a Mediterranean species, living in vineyards and orange groves, and on warm, bushy slopes. In these places they are still common, and yellowhammers have to nest in mountainous regions to avoid competition. As you might expect, in England cirl buntings only remain in the south and south-west – areas with relatively warm summers and mild winters.

Left: Female cirl bunting at her nest. Cirl buntings choose sheltered farmland habitats with tall hedges and trees, woodland edges, parkland and heaths, especially on south-facing slopes on chalk downland and in coastal valleys. The decline of the cirl bunting may be partly due to destruction of habitat, and also to disturbance; but the underlying factor is probably a change in the climate. The bird is a sedentary species and cannot escape bad weather; our cooler, wetter summers and occasional hard winters since the mid-century have not been to its liking. Outside this country, the cirl bunting is resident in south and west Europe and north-west Africa.

THE CHANGING FACE OF ORCHARDS

Once much more widespread, the spectacular beauty of orchards in full blossom is now confined mainly to southern England. Indeed, its orchards have gained Kent the nickname 'The Garden of England'.

Orchards were once plentiful in Britain but now Kent, together with some other counties in the south-east, East Anglia and south-west England, are the only remaining areas with a sizeable acreage of orchards. While we may regret the passing of this rapidly diminishing part of our landscape, it is worth remembering – to set the loss in context – that some 2000 years ago much of Britain was forest-clad, and that substantial clearances for agriculture are less than 500 years old. Thus, in environmental terms, orchards are relative newcomers to our scenery.

What are the reasons for this decline? Probably the most important are a combination of economic pressures, including

Above: A modern apple orchard near Maidstone, Kent. The short trees make picking very easy, and weedkiller sprays eliminate all the plants around the trees that may compete with them for water and nutrients.

Previous page: An old-fashioned cherry orchard in blossom in Worcestershire.

Tree fruits

Tree fruits occur in two forms: stone (cherries and plums), and pome or pip (apples and pears), these names relating to the nature of the seed within the fleshy fruit. There is an exception—the hazelnut—which used to be grown widely in plantations.

competition from the Continent. Most tree fruits are at the edge of their natural range in Britain; even in the primeval forests the wild ancestors of our modern cultivated varieties of fruit—bird cherry, crab apple, wild pear and wild plum—would have been relatively scarce and most noticeable in the south and south-east. Consequently, fruit can be grown better, faster and more economically in southern Europe. The many more hours of summer sunshine and the cheaper labour of southern European countries, combined with the removal of trade barriers and the development of speedy and effective means of transporting fruit in bulk, indicate how much the English fruitgrower has to face in the way of competition.

Competition also takes into account developments in the last few years of refrigeration techniques on board ships and in cold storage facilities ashore. These have allowed many modern apple and pear varieties to be kept for several months before marketing. As a result, it is possible to see southern hemisphere fruit—from Australasia and South Africa—competing very effectively with our own, despite the distances the fruit must travel.

Changes and improvements Our orchards have changed, not only because of competition from overseas, but also in the normal processes of agricultural improvement.

Along with a drastic reduction in acreage, the methods of growing fruit have changed. Gone are the orchards of the past, when apples and cherries were grown on huge old trees. So tall were these trees that fruitpickers commonly had to work (inefficiently) from 60-rung 'skyscraper' ladders. Low-yielding varieties have been grubbed up, however good their flavour, and so, too, have all the gnarled old orchards rich in holes for nesting birds like tits, tree sparrows, starlings and even little owls. It may even be that the passing of these decrepit orchards sealed the fate of the wryneck, a strange, woodpecker-like bird that is now extinct in southern England where it was widespread in orchard country only 30 years ago.

What remains is far more uniform. The rootstocks on to which our fruiting varieties are now grafted have all been classified at East Malling Research Station in Kent, and are produced by means of cuttings from stool beds to ensure that the fruit develops true to type. This is the reason why the trees in an orchard today are all the same size as each other, rather than a hotch-potch of sizes as in the past. Rootstocks are available that allow the fruitgrower to choose the size of tree he will grow, and also to give him some control over how quickly the orchard will come into fruit.

The modern trend is towards a short, dense plantation that is easily pruned and picked (sometimes even without the help of a ladder). This type of plantation makes the most efficient conversion of energy from sunlight into leaves, wood and, above all, fruit. Appropriately 'dwarfing' rootstocks are readily available for apple and pear trees and are beginning to emerge from the fruitbreeders' programmes for plums and cherries—although there is still some way to go for these.

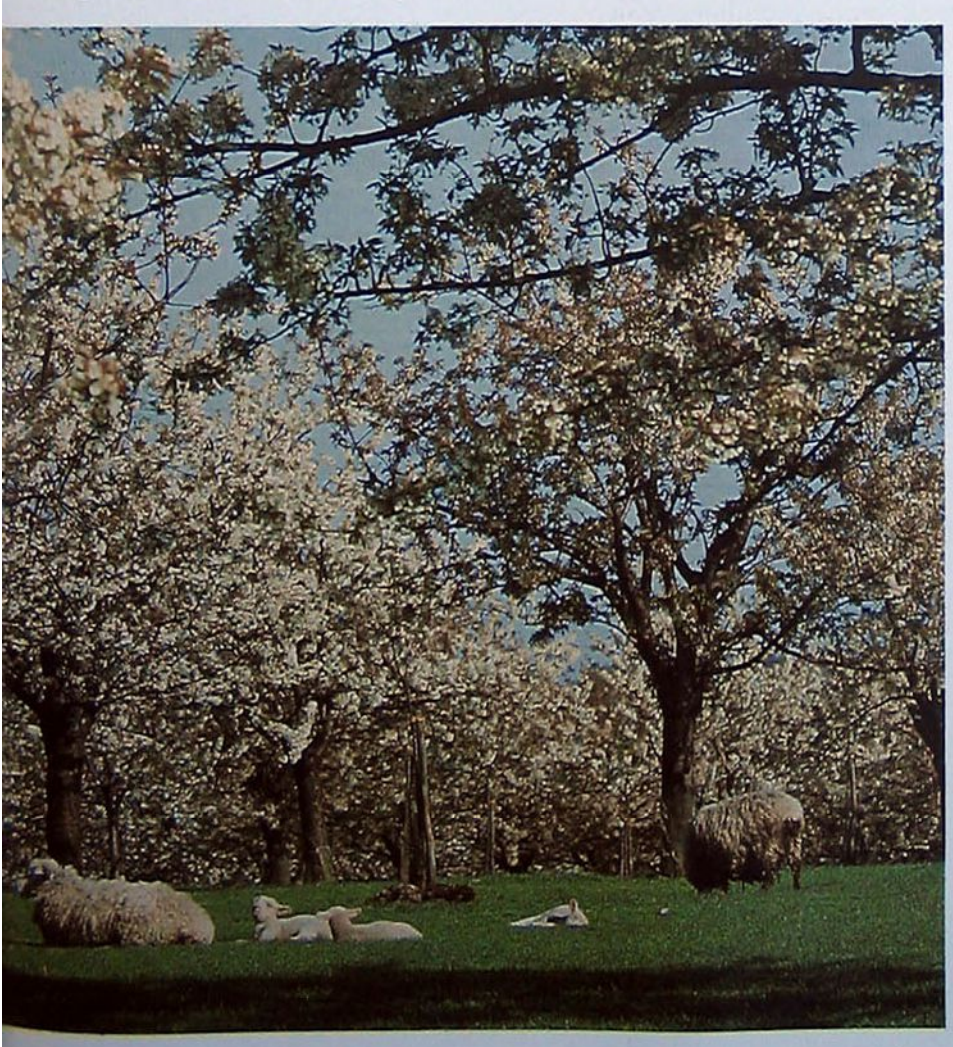
These smaller trees have a shorter productive life, and we should now expect to see a regular turnover of orchards—something that will allow fruitgrowers to be more

flexible in responding to changes of preference in the fruit-eating public, and to take quick advantage of any new varieties that fruit-breeders at Research Institutes like East Malling can produce.

The ever-popular Bramley remains unequalled as a cooking variety of apple, for instance, but the choice of dessert apples is wide. Cox's Orange Pippin is renowned for its texture and flavour, but it is a poor cropper and prone to various diseases. Fruit-breeders are seeking an equally tasty but more profitable replacement for the Cox, as well as extending the range of high-yielding, crisp, juicy, well-coloured varieties to tempt the housewife. Out of favour now, despite the flavour of the fruit, are such old-fashioned varieties as Egremont Russet or Ellison's Orange Pippin, and in have come new ones like Suntan, Spartan and Crispin.

Orchard management The last 30 years have seen many turn-abouts in the fashions of orchard management. The enormous old trees were tall enough to have livestock, especially sheep, grazing the grass beneath them (applying natural manure at the same time). The smaller size of modern trees has, however, eliminated the sheep, and increased dependence on synthetic fertilisers, which are usually oil-based products and thus increasingly costly. Hence, what started as an economy of one sort has turned out to bring with it an unexpected expense.

Above: With the removal of hedgerows, and the plants associated with them, from the vicinity of orchards, birds such as the bullfinch may have been 'forced' to turn to fruit tree buds to supplement their diet.



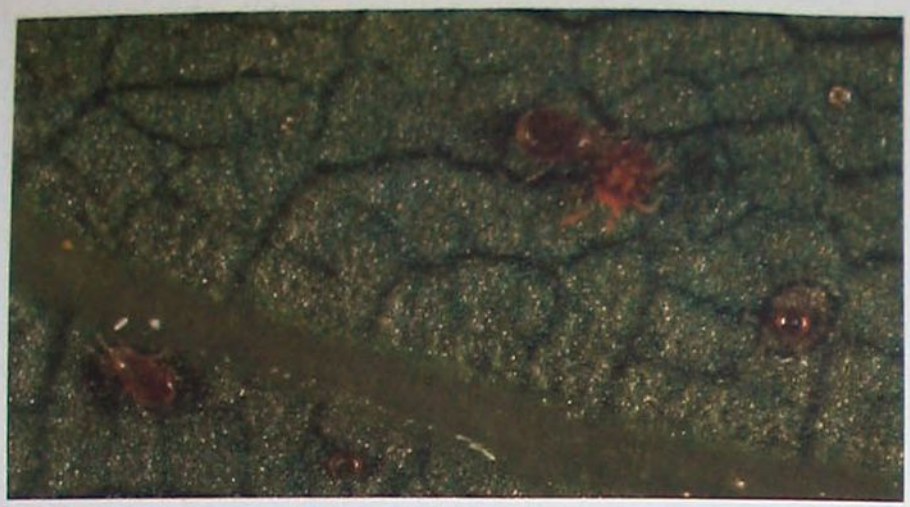
Below: Sheep grazing in a cherry orchard in Kent, under tall, old-fashioned trees. As sheep graze they fertilise the ground naturally. More modern trees are too short to allow grazing and so artificial fertilisers must be applied.

In the past, too, many ungrazed orchards were clean-cultivated, regular harrowing keeping down the weeds to a greater or (often) lesser extent. Some were planted with grass to allow tractors towing heavy spraying machinery to pass easily along the rows of trees without bogging down, but this made regular mowing necessary to keep the grass under control. Then it was realised that the grass was an effective competitor with the fruit trees for both water and soil nutrients. Therefore, with the coming of modern generations of herbicides, or weedkillers, first strips, then wide bands (and occasionally whole orchards) were treated to improve growth and cropping, and to eliminate most 'weeds'–docks and nettles for instance–that used to be common.

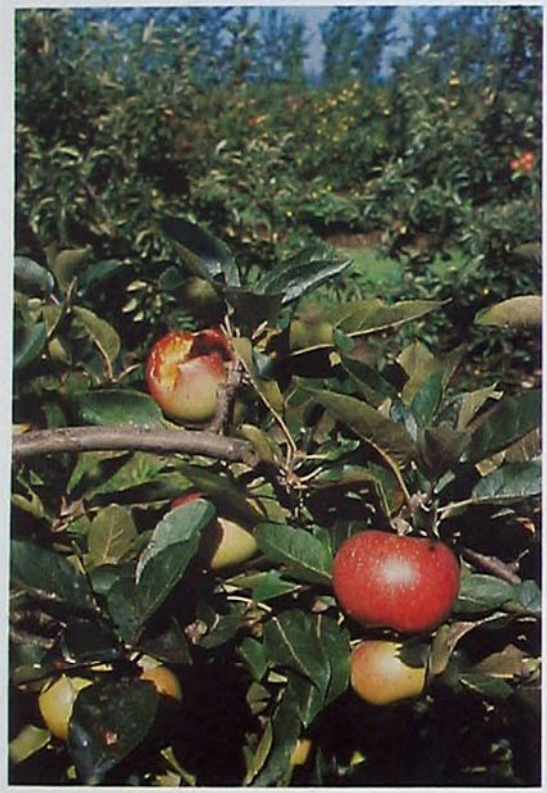
Overall, this has resulted in a marked reduction in both the numbers and the variety of wild plants within the orchard. In a modern, well-managed orchard only a few broad-leaved species of plants resistant to herbicides, such as red dead-nettle, now remain. Additionally, research has shown that hedges may contain many hosts of plant virus diseases, so the hedges, too, have often been removed, resulting in the loss of a variety of annual and perennial plant species. The hedges have usually been replaced with a windbreak of just one species, often alder, poplar or a conifer.

Management of insect pests Clearly, any reduction in the range of plants in and around an orchard also reduces the number of insects. Ironically, it is now often considered necessary to import beehives, especially during the flowering season, to improve pollination.

Since the turn of the century, too, we have been applying lethal insecticides to control insect pests. We tend to think of modern pesticides as being the ultimate destroyers of wildlife, but the early insecticidal materials, which included lead, arsenic and nicotine, were just as lethal to man and the other creatures of the orchard environment. It is only fair to point out that much of the excessive use of pesticides in the past has been due to us, the consumers, demanding absolutely blemish-free fruit in the shops.



Above: A predatory mite (the brown, pear-shaped one) attacks and pierces a pest red spider mite, sucking out its body contents and killing it. Such predators now keep red spider mite numbers at harmlessly low levels in many orchards—an excellent example of biological control.



Left: Pest damage of a different kind: this apple (it is Discovery, a new variety) has been part-eaten by a parakeet—one of a wild population that now breeds freely in south-east England and sometimes damages fruit, as parakeets do in their Australasian homeland. The feral population probably originated from parakeets that escaped from zoos.

Today we are seeing a reversal in the pesticide trend. Like fertilisers, pesticides are often oil-based, and a modern material may cost around £20 million to develop. Hence they are becoming too costly to apply. More and more fruitgrowers are seeking to reduce pesticide usage and increase the help they can obtain from natural insect predators in controlling pests. Careful selection of pesticides that do not harm these predators allows biological control to work. A particularly good example is in the control of red spider mite, a major pest, as recently as the 1960s by another group of insects, the predatory Phytoseiid mites.

Birds in orchards For birds, the more 'hygienic' the orchard maintenance, and in particular the more effective the weed control, the less attractive the orchards will be. Seed-eating birds like chaffinches and linnets are the main sufferers, but worms usually remain, together with fallen and rotting fruit, to tempt the various thrushes.

It may be that this tendency to weed-free orchards has 'forced' the bullfinch, for instance, to turn more often to eating fruit buds to augment its winter diet. Certainly, the breeding of a soft, juicy, bright red early apple like Discovery has brought an inevitable spate of damage from starlings. Damage to ripening fruit by these birds has also been a major factor in the decline of the cherry industry.

On the credit side, the many miles of alder windbreaks planted during the last decade now tempt attractive redpolls and siskins into orchard country in ever-increasing numbers, whereas they were once scarce birds found only among stream-side alders.

Changes there have certainly been, and other changes are still to come as agricultural and economic factors influence farming. It seems unlikely, however, that the reduction in orchard acreage will be halted.

Right: Easy picking and heavy crops on a modern apple plantation at Malling in Kent. During this century there have been sweeping changes in orchard management (including the appearance of such trees as these), some of which seem to be detrimental to wildlife. However, not all the changes have been for the worse as far as the countryside is concerned. Orchards remain particularly attractive to look at and a quick glance at, for example, the numbers of birds feeding in them during the winter, shows that they still have a positive contribution to make to the rural landscape and its wildlife.

FAR-FLYING MIGRANT MOTHS

Some of our powerful hawk-moths are not resident species, but migrants, travelling over great distances before finally arriving on our shores.

Above: The aptly named death's-head hawk-moth (*Acherontia atropos*) is able to pulsate the skull-like marking on its thorax, giving it an alarming look.

Below: The humming bird hawk-moth (*Macroglossa stellatarum*) feeds on flowers such as petunias by extending its long proboscis to reach the nectar.

Nine of the eighteen species of hawk-moth found in the British Isles are migrants, although four of them arrive here only rarely and irregularly. The more common migrants are the humming bird, convolvulus, death's-head, striped and bedstraw hawk-moths.

These migrants generally arrive between late spring and the autumn, with the death's-head, convolvulus and the very rare oleander and silver-striped hawk-moths appearing most frequently in the autumn. The reason for this is that their winter home is in Africa and, in general, those breeding in Europe have migrated from there in the early spring. They breed again, producing a larger second generation which arrives in the British Isles in late summer or autumn.

When breeding success is low, few if any hawk-moths move very far from their breeding sites. When it is high, the breeding areas become overpopulated, resulting in a shortage of foodplants which forces the moths to seek them elsewhere. Hence unusually large numbers of hawk-moths may reach Britain.

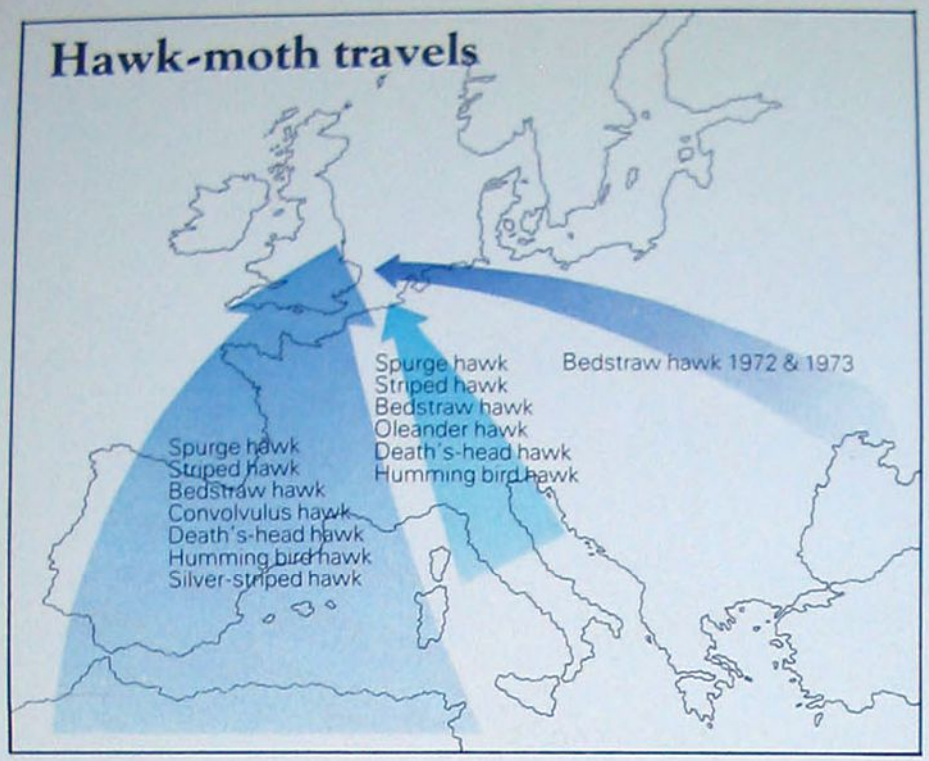
Bird-like moth Of all the migrant hawk-moths visiting Britain, the humming bird hawk is the most regular and usually the commonest species. This day-flying moth is resident in southern Europe, especially in the Mediterranean.

In the spring, many humming bird hawks disperse northwards throughout Europe and some may reach Britain quite early in the year. A few humming bird hawks have been recorded hibernating in southern England in most winters and in fact they have been recorded here in every month of the year, although not in significant numbers.

The first humming bird hawks usually arrive in early summer, especially June. The females lay their eggs on various bedstraws, giving rise to a British-bred summer generation of moths. The green or brown caterpillars feed during July and August and, when full-grown, they construct rather flimsy cocoons. These are made from soil particles, dead leaves and other debris, spun together with silk, and they lie among the foodplants of the ground litter. The moths emerge after about three weeks.

When a humming bird hawk-moth feeds on a flower, its wings beat so fast that they may appear as a hazy blur, emitting a high-pitched hum that is audible at close range. Not surprisingly, many people actually mistake it for a humming bird. The resemblance is remarkably close; the long black and white scales at the end of the abdomen are spread out like a bird's tail, and even the eyes are incredibly bird-like.

Convolvulus hawk-moth The next commonest hawk-moth visitor to the British Isles,



found most often in the south-east, is the convolvulus hawk. This is a large, fast-flying grey-brown moth with a wingspan of up to 12cm ($4\frac{3}{4}$in). Found as far away as Australia and the Pacific region, these moths breed during the summer in many parts of Europe. Most convolvulus hawk-moths fly here direct from the Mediterranean, and some of them may lay eggs here. These, bright green and very small for so large a moth, are laid on various species of convolvulus. However, the eggs rarely develop into caterpillars; the ones that are found are nearly always discovered feeding on field bindweed in potato fields.

A full-grown convolvulus hawk-moth caterpillar is a striking creature some 10cm (4in) in length, with a curved, black-tipped chestnut-red 'tail' horn. It is highly variable in colour and markings, although two main types occur: one bright green with dark spots and stripes, the other dark brown with yellow or pinkish stripes.

Before pupating, the caterpillar burrows deep into the soil and forms a large, hollow underground chamber. When this has been completed, it changes into a large, reddish-brown pupa. In the main part of the moth's breeding range, pupation takes about three weeks, but farther north the moths may take much longer to emerge. In Britain, few emerge successfully, and caterpillars pupating late in the autumn have little chance of surviving our cold, wet winters.

The death's-head These huge, bulky hawk-moths usually reach Britain in late spring and also in August and September. They are most often found in the south and the east, although they have been recorded from all parts of the British Isles. Usually only a few are reported each year, although on occasion exceptional numbers may arrive. They never feed from flowers, but are sometimes seen sucking sap from trees as well as raiding bees' nests for honey.

The females deposit their eggs singly on the stalks of potato plants and on nightshades and related species, often in fields near their point of arrival on the coast. Early arrivals may produce caterpillars in July–and thus some British-bred moths–but the majority of death's-head hawk-moths seen in the autumn are fresh immigrants from the Continent.

The caterpillars are very large and distinctive. They vary in colour and appearance from a green form, with seven oblique yellow-edged purple stripes on its flanks, to a yellow form with white-edged purple oblique stripes.

Like the convolvulus hawk-moth, the caterpillar constructs an underground cell for pupation. The large, glossy dark brown pupa wriggles vigorously and often squeaks when touched. The adult moth also squeaks by forcing air through its proboscis. It squeaks freely if disturbed and it seems that this

Above: Favourable winds, coinciding with a large emergence of moths in an area far removed from Britain may lead to an exceptional invasion by some species in certain years. This happened in 1973 when large numbers of bedstraw hawk-moths arrived, apparently directly from eastern Europe.

Right: The large convolvulus hawk-moth (*Agrius convolvuli*) has a very long proboscis with which it probes petunias and other tubular flowers at dusk, and again at dawn, hovering before them with a humming sound. Its large, reddish-brown pupa (below) is unmistakable because of the curved, partly detached proboscis case which looks like a jug handle.

behaviour may have a defensive function, although this cannot be the only explanation as unmolested moths often squeak to each other or to themselves.

The death's-head hawk-moth used to be known as the 'bee-tyger' because of the wasp-like blackish and yellow markings exposed as warning coloration. Its whole appearance is made more threatening by the death's-head marking on its dark thorax. The moth can reinforce its warning display by squeaking loudly and lashing out with its black forelegs.

Rare immigrants The bedstraw, spurge, striped and silver-striped hawk-moths are all medium-sized moths, but swift, powerful flyers nevertheless. All of them are rare and irregular immigrants to the British Isles, although occasionally large influxes occur.

In Britain, striped hawk-moths are usually seen for a short time at dawn and dusk, hovering in front of petunias, red valerian and other plants while they probe the blossom for nectar. The other rare species behave in much the same way, and all of them are frequently attracted to artificial light. With the exception of the spurge hawk, they have been recorded from many parts of the British Isles, but they are most likely to be encountered in southern England, often in gardens.

The striped hawk-moth is perhaps the most regular of these rarer visitors. Found in almost every part of the world, it breeds each year over much of Europe. A few reach Britain almost every year in late spring, late summer and early autumn. On the rare occasions when large influxes have been reported, the large caterpillars have also been found. These make flimsy cocoons of earth, plant debris and silk on or just under the ground. Late pupae are highly unlikely to survive the British winter in the wild.

The large caterpillars of the bedstraw hawk-moth are also sometimes seen here. Measuring nearly 7.5cm (3in) long, they are variable in colour, but strikingly patterned with large, black-ringed yellow spots. They are most likely to be encountered feeding upon bedstraws and willowherbs growing on coastal sand dunes, where they seem to like sunning themselves on the hot sand.

Two great rarities in the British Isles are (above) the spurge hawk-moth (*Hyles euphorbiae*) and (left) the silver-striped hawk-moth (*Hippotion celerio*). Although they are often numerous in Europe, only a few of them find their way here and in some years none are reported at all. Their caterpillars are also great rarities here. The showy, unmistakable caterpillars of the spurge hawk-moth, chiefly attired in bright red and black warning colours, feed on various spurges. The caterpillars of the silver-striped hawk are usually green or brown in colour with warning eyespots, and feed on grape-vines.

Above: Caterpillar of death's-head hawk-moth. Measures up to 12.5cm (5in). Feeds on potato plants.

Below: Striped hawk-moth (*Hyles lineata livornica*). Caterpillar feeds on docks, bedstraws and snapdragons.

Above: Bedstraw hawk-moth (*Hyles gallii*). Caterpillar feeds on bedstraws and willowherbs.

AQUATIC ROSETTES

In mountain lakes and pools where conditions can be harsh, many of the aquatic plants grow in a standard rosette shape, sometimes forming thick carpets underwater.

Above: The underwater rosettes of the perennial water lobelia (*Lobelia dortmanna*). The flowers (below) are produced on slender stalks, well above the water's surface, from July to August. They are thought to be pollinated by insects, producing seed capsules which may each contain over 100 seeds. These are released from the capsule and fall to the water where they sink and later germinate.

In the mountainous northern and western counties of the British Isles, lakes, tarns and boggy pools are common. These are low in mineral salts, although occasionally peat collects there and gives the water a brown coloration, as well as making it acid. The water is generally shallow, but its level is maintained by the high rainfall of these regions. In exceptionally hot weather the lakes or ponds may recede or dry out, while during the long, cold winters experienced in these parts of Britain, the shallower waters may freeze completely.

Environmental adaptations The plants which grow here have had to adapt to this exacting environment and, as a result, have all evolved a very similar appearance. They have narrow, undivided leaves produced in a stiff tuft or rosette from the base of the plant, and the stems are short and generally well-rooted.

The root performs two main functions. The first is to take up mineral salts from the ground as these aquatics are not able to take advantage of the water-borne supply available to other aquatics in richer waters. The second function is to guard against the effects of wave action by anchoring the plants firmly on the lake bed, which is usually composed of fine gravel from rocks such as granite, sometimes overlaid with peat.

As bottom-dwelling plants, these aquatics are dependent on light filtering through from the surface and so tend to be restricted to shallower lakes, or the margins of deeper ones. Some of the species produce flowers above the surface and are found nearest the edge of the water. These marginal species may be found growing out of the water at different times of year, as the water level fluctuates.

Essential light Rosette-aquatics have been affected by the drainage and agricultural utilisation of the wetlands. Artificial fertilisation of pastures and crop fields has caused 'run-off' into ponds and lakes and altered the mineral balance of the water (a process known as eutrophication). The dense growth of algae, or algal bloom, which flourishes under these conditions drastically reduces the quantity and quality of light reaching the lake floor. The green 'soup' of algae effectively filters out those wavelengths of light essential for photosynthesis. The bottom-dwelling plants are particularly affected by these conditions, more so than those aquatics that have stems or leaves floating on or near the surface. As rosette-aquatics cannot tolerate pollution of their waters, they are now extinct in many counties of the British Isles.

Zonation of species These aquatic species form different zones or bands of plants around the margin of the lakes. Shoreweed, as its name suggests, grows in the shallow water nearest the shores of lakes and at the margins

of ponds and reservoirs. Although flowers are only found on the terrestrial forms, this species does not rely solely on seed for the production of new plants. Abundant creeping stems, called stolons, grow away from the plant, producing rosettes of new leaves at intervals. Each rosette forms its own roots and in time becomes an independent plant. Shoreweed can thus colonize large areas quite rapidly, excluding more delicate species such as awlwort.

Beyond the zone of shoreweed, the handsome, nodding, pale lilac flowers of water lobelia appear. While this species prefers water no deeper than 30cm (1ft), sterile rosettes have been found at depths of 3m (10ft). Water lobelia is less capable than shoreweed of withstanding a drought, during which many plants may die.

This species lacks shoreweed's method of rapid propagation, although buds at the base of the leaves may produce new rosettes after the old one has flowered. These new rosettes become detached and are carried away by the water to new localities. However, water lobelia mostly reproduces by seeds, and it is one of the few true aquatics that produces its seeds above the water's surface.

The flowers of awlwort can be successfully pollinated even when totally submerged, so this species is often found growing with water lobelia or further out with the quillworts. A relative of radishes and cabbages, it is an annual, producing four-petalled flowers in the shape of a cross from June to August. These are often completely submerged and pollinate themselves, although flowers produced in the air on plants near the water's edge may be insect-pollinated. The species takes its name from its slender, grass-like leaves which taper to a point at the tip, resembling the end of a shoemaker's awl.

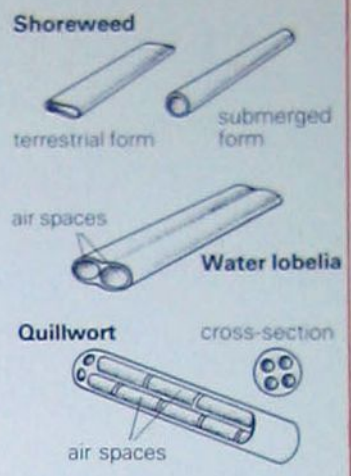
Quillwort is not a flowering plant, but a spore-bearing species related to the horsetails and ferns. It produces its spores in sporangia on the swollen leaf bases and reproduction is carried out under water. These plants usually grow furthest from the water's edge, although rarely at depths of more than 8m (26ft).

Fellow aquatics Pipewort is another species that favours the same types of habitat as shoreweed, water lobelia and quillwort. It is found on lake margins or in shallow water in parts of the Scottish Islands and western Ireland only, so it is rarely encountered. A more common species is pillwort, an unusual relative of the ferns. The 'leaves' or fronds are produced singly along a creeping stem, often in such profusion that the plant forms a dense 'turf' like the rosette-aquatics. Pillwort is found on the edges of pools, in or out of the water, often on acid soils. While the leaves are still young, they are curled at the tip in the shape of a typical fern crozier.

Oxygen uptake in aquatics

The active growth of roots and uptake of mineral salts depends on energy released during respiration, a process requiring oxygen. This is present in small amounts, dissolved in water, but the green leaves of plants can manufacture oxygen from carbon dioxide during photosynthesis, transporting it to the roots via the air spaces found in the stems and leaves of many aquatics.

The distribution of air spaces varies – numerous spaces are scattered through the leaves of both forms of shoreweed. The two-lobed water lobelia leaf has a large air space in each half, and there are four air spaces, divided by cross walls, in the rounded leaf of quillwort.

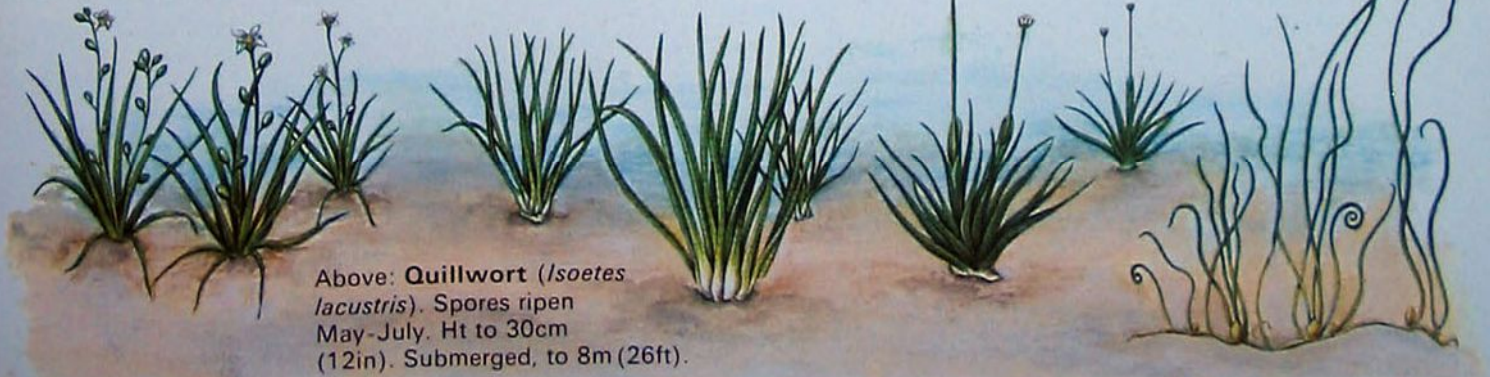


Below: Shoreweed (*Littorella uniflora*) can tolerate drought by becoming terrestrial if the water level drops considerably. The flowers are formed only under dry conditions, separate male and female flowers being produced on the same plant. The male flowers are borne on stalks to expose the long anthers to the wind. The wind carries the pollen to the elongated stigmas of the stalkless female flowers.

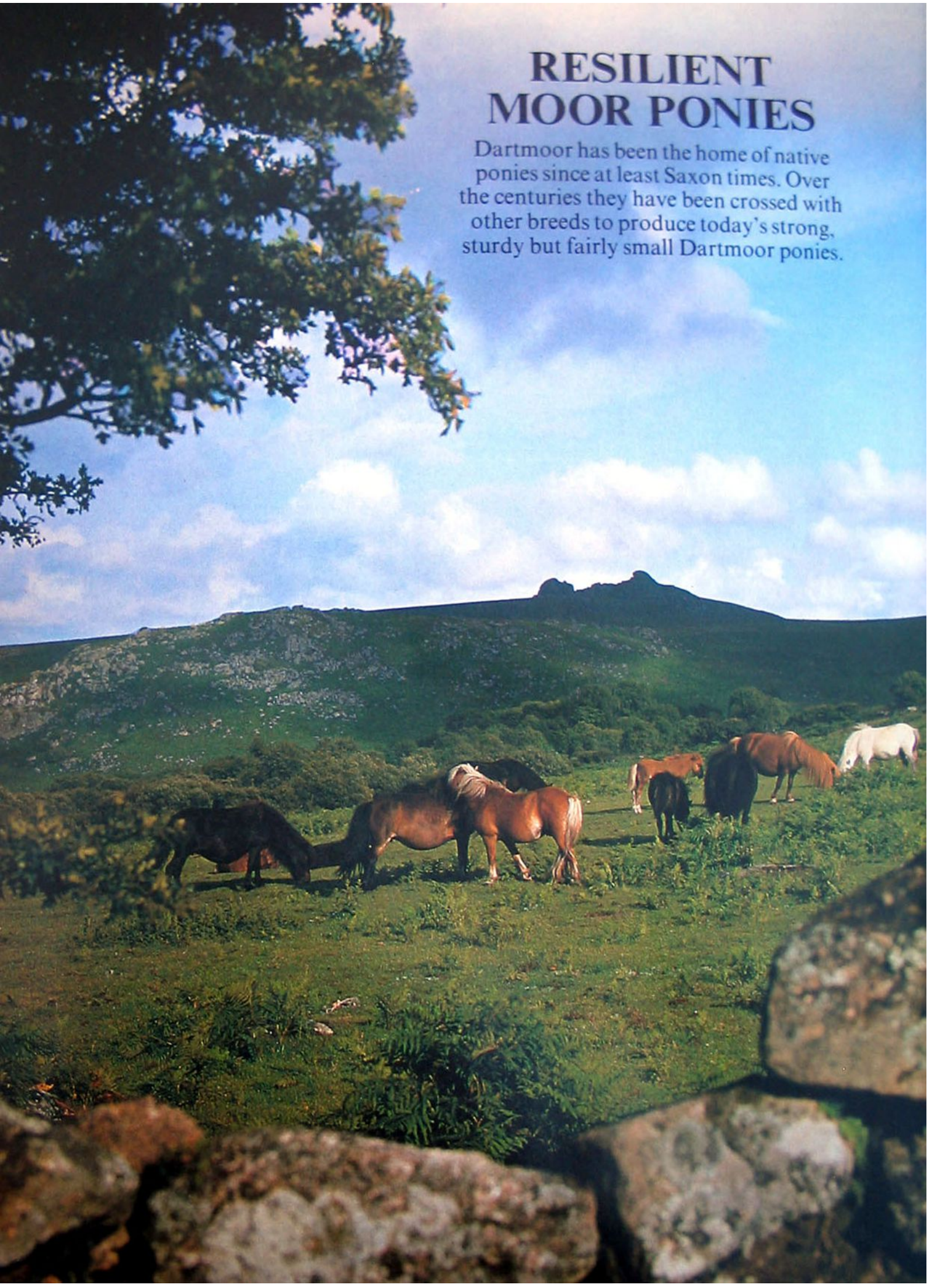
Below: **Awlwort** (*Subularia aquatica*). Flowers June-August. Ht to 75cm (3in). May be submerged.

Right: **Pipewort** (*Eriocaulon aquaticum*). Flowers July-Sept. Ht to 10cm (4in). Found in shallow water.

Right: **Pillwort** (*Pilularia globulifera*). Spores ripen June-Sept. Ht to 10cm (4in). Found at water's edge.



Above: **Quillwort** (*Isoetes lacustris*). Spores ripen May-July. Ht to 30cm (12in). Submerged, to 8m (26ft).



RESILIENT MOOR PONIES

Dartmoor has been the home of native ponies since at least Saxon times. Over the centuries they have been crossed with other breeds to produce today's strong, sturdy but fairly small Dartmoor ponies.

Left: Dartmoor ponies in their native habitat, with Haytor in the background. The most common colours of Dartmoor ponies are brown, bay and black, with some greys and an occasional chestnut. Piebalds and skewbalds are not permitted under the rules of the Dartmoor Pony Society.

Right: Dartmoor ponies travel immense distances to find food, coping well with boggy conditions, even though they may sink in right up to their bellies.

The modern Dartmoor pony is smaller, on average, than its ancestors of a century ago, and is one of the most elegant and beautiful of the British native breeds. It is one of our smaller ponies, standing no more than 12.2 hands (50in) high at the withers, with the typical small, alert-looking pony head, big, bold eyes, and tiny ears. The breed has the strong legs and good strong feet necessary to withstand the rough, rocky ground of the Moor.

Today there are few registered pure-bred ponies on the Moor: most of those turned out on the Moor each year are part-breds. The majority of pure-breds are found on private studs and, as almost always happens when ponies are bred away from their native habitats, the stud-bred animals tend to be more refined and to lose some of their hardiness compared with the moor-bred ponies. A recent attempt to turn a stud-bred pony out on the Moor to find its own food and live the natural life of its predecessors has proved a failure; it had to be moved down to better pasture in the hard weather.

The ponies that do live on the Moor, however, are adapted to their bleak environment, both physically and in their behaviour patterns. Their thick manes and tails give them protection against wind and rain, and in August–far earlier than their stud-bred relatives–their thick winter coats begin to come through and last at least until the following May.

Although the Breed Society standard requires that Dartmoors have high set tails, it is sometimes said that the tails of the Moor ponies are set rather low. Similarly, the Breed Society demands a small head, but moorland farmers sometimes maintain that ponies with larger heads are hardier. This is probably because they are less carefully bred; for instance, they may have some hardy Exmoor blood in their ancestry.

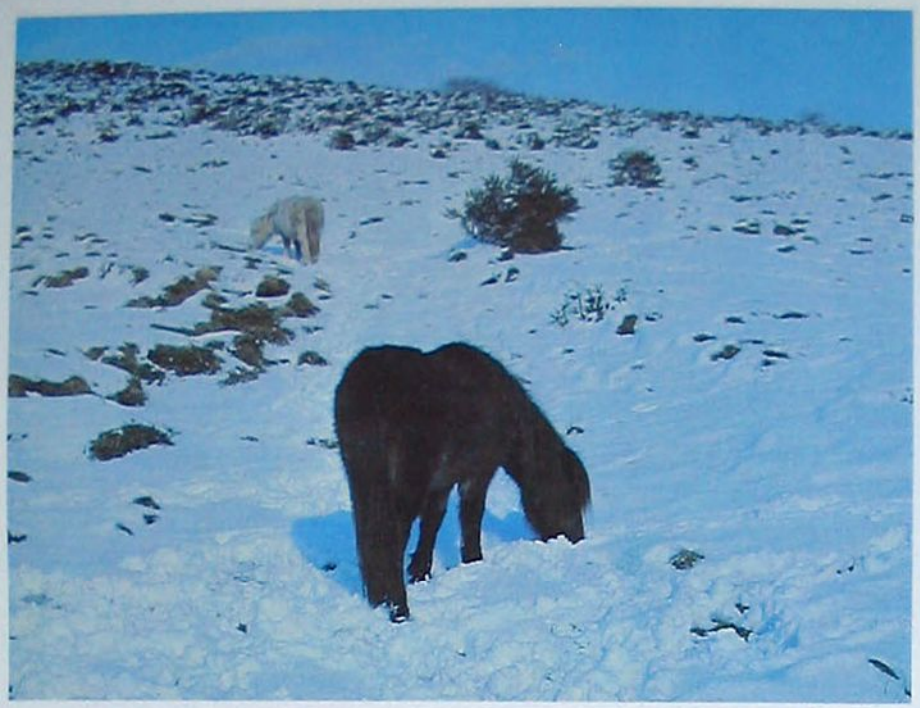
Little feathering Unlike heavier native breeds from the north, Dartmoors living on the Moor have only a little feathering on their lower legs in winter. There are two possible explanations for this: although Dartmoor is cold and bleak in winter, it is not normally subjected to the prolonged periods of snow found further north, so there is less need for feathering for protection; alternatively, it may be that the Dartmoor breed, although influenced by many others, has not been crossed to any significant degree with breeds which have heavy feathering. Most stud ponies have little, if any, feathering. The overall result is that Dartmoors, while still retaining the strength and sturdiness typical of native ponies, look far more like riding ponies than their heavier northern counterparts.

Varied diet Foraging for food occupies much of the ponies' life on the Moor, and they cover considerable distances to obtain their principal foodstuffs. They eat various moor grasses, and rushes, which they bite off almost to the ground, and even gorse in winter when it may be the only food plant visible above the snow. Some ponies eat heather or the tips of bracken: they do not seem troubled by the bracken poisoning that often strikes down non-native breeds. They are particularly fond of the sweet young grass that grows up after burning off, and in some instances they even eat the charcoal stems of burnt gorse. They also take fodder put out for cattle.

In spring the ponies penetrate the infamous Dartmoor bogs in search of an early spring bite of bog grasses which sheep and cattle cannot reach. They may go in right up to their bellies, but only the occasional weak or poor-conditioned pony becomes trapped.

The ponies may be infested by worms from the vegetation, and may also be quite seriously debilitated by ticks, most of which almost certainly come from the sheep.

Weather forecasters Most native ponies are excellent weather forecasters, and the Dartmoors are no exception. When they are seen standing with their tails up against rocks or walls, it is a sure sign that a storm is on the



way. Before snow they become restless and gallop about, possibly looking for shelter. Where possible, they go down to the valleys. In the old days, before cattle grids were put across the moor access roads, the ponies came right down into the villages in winter, and used to wander along the lanes for many miles beyond the boundaries of the Moor. They were known as 'lane creepers', and they found quite good feed in the hedgerows and banks.

Herding habits The Moor ponies live in herds with a clearly defined herd structure, headed by a stallion who collects anything from 6 to 30 mares around him. Each herd has its own territory or 'lear', which includes both winter and summer grazing areas.

There is some variation in herd behaviour depending on the character of the lear. Around the edges of the Moor, where roads and cattle grids have tended to divide the country into small pockets of land, the mares may roam out of sight of the stallion.

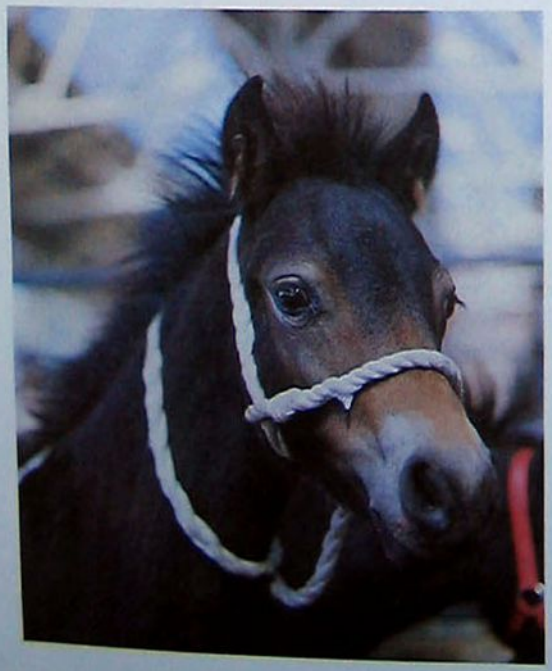
Above: The winter coats of Dartmoor ponies are known locally as 'blackberry coats' because they start to grow when the blackberries are ripening in early autumn.

Up on the open Moor, however, where herds may occupy adjacent territories, the stallions usually herd their mares much more aggressively, particularly during the breeding season. They round them up, occasionally nipping the stragglers. If a neighbouring stallion dares to stray into the next door territory, the resident stallion behaves with considerable aggression, laying his ears right back and making threatening runs towards the intruder. At close quarters some quite vicious kicking and biting may occur. Rarely, however, is any serious damage done. As the stallion gets older, he tends to lose some of his mares to younger, stronger rivals.

Breeding The breeding season is from April until July, starting later and finishing earlier than that on the studs, because of the Moor's more rigorous conditions. Occasionally a mare foals in January or late autumn. This happens most often after a harsh winter when the mare has 'slipped' (aborted) a foal, and has then been 'covered' by the stallion much later or much earlier than normal. Dartmoor mares, in contrast to the Fell pony mares, tend to stay with the herd when they are foaling and some, usually the younger ones, actually foal down right in the centre of the herd.

A herd stallion never mates with his own daughters who often stay with the herd until they are about two years old. The stallion then beats them off, and they are eventually

Above: A Dartmoor pony on the edge of the Moor, with Challacombe Down in the distance.



Left: A pony at a sale. During World War II the ponies on the Moor suffered as American troops used them for target practice, and since then the breeding of pure-breds has declined on the Moor. Nevertheless the breed has flourished in private studs, producing ponies that are ideal for children to ride. They also go well in harness.

taken into the herd of another stallion, thus limiting the likelihood of damaging inbreeding. In general stallions do not mate with fillies that are only two years old. This is a natural way of protecting the quality of the breed, because a two year old, although physically capable of breeding, often produces a puny foal. This is partly because she is still growing actively herself, and she cannot, under the harsh conditions, provide sufficiently well for herself and for the foal she is carrying.

The foals usually stay 'on' the mares (unless removed from the moor by their owners) until the mares have another foal. If a mare is barren for a year, the previous year's foal

may be suckling her when it is well over a year old. In general, Dartmoor mares have a long breeding life, sometimes foaling when they are 20 years old or even more.

Ponies in demand Although there are relatively few pure-breds left on the Moor, the ponies turned out there are still in demand as riding ponies, and, regrettably but inevitably, for the meat and pet-food trade. In the autumn the moorland farmers hold 'drifts' (round-ups) which take on an almost Western flavour as the ponies are herded down off the Moor. They are sold at a series of sales at Tavistock, Ashburton, Hatherleigh and Chagford.

The filly foals are branded (on the back, and sometimes on the hoof – the latter needs re-doing as the hoof grows) and are usually turned out on the Moor again for breeding. In recent years, because of criticism of the poor conditions of some ponies during the winter months, farmers take the current year's foals away and return them in spring. In this way, both foals and mares are protected.

Dartmoors and man For centuries the ponies of Dartmoor have been influenced in a number of ways by man. The late Sylvia Calmady-Hamlyn, an historian of the breed, believed that native ponies arrived on Dartmoor and Exmoor at about the same time, having been driven from eastern Britain by the Saxon invaders. The ponies on the two moors, however, have developed quite differently. Exmoor has always been more isolated, and consequently the ponies there have been almost totally uninfluenced by other breeds.

Dartmoor, on the other hand, has always been the most direct route between the coastal towns of Exeter and Plymouth, and from the Middle Ages it was a major trading route. The traders brought all kinds of horses and ponies, some of which interbred with the natives, and in time a breed evolved which was on the whole rather larger than the present day ponies. Indeed, it was not until 1924 that the official height for Dartmoor ponies was reduced from 14 hands (56in) for stallions and 13.2 hands (54in) for mares to the present 12.2 hands (50in).

The most recent, and arguably the most disastrous, outcrossing on a large scale began during the Industrial Revolution, when many Shetland pony stallions were introduced to produce smaller ponies for the pits. Before this the ponies had been used by the Moor farmers for riding, farm haulage, and for draught work in the local tin mines.

The crossing with Shetlands produced pit ponies but did nothing to enhance the breed as riding ponies, and there was widespread degeneration into unattractive ponies that were too small to carry the average farmer.

In 1902 the Dartmoor Committee decided not to pass any more ponies known to have more than 25% alien blood.

Above: Dartmoor ponies near Scorhill Circle on Gidleigh Common in early April when food is still quite scarce.

DARTMOOR PONY

Size Maximum height 12 hands 2 inches (127cm/50in) at the withers.
Colour Brown, bay, black, a few greys, an occasional chestnut.
Breeding season April until July on the Moor; starting a little earlier and finishing later on studs.
Gestation Approximately 11 months.
No of young Normally one.
Life span Up to 25 years, sometimes more.
Food Coarse grasses, rushes, gorse, heather, bracken.
Breed Society Dartmoor Pony Society.
Where to see Dartmoors: A few pure-breds still live on the Moor. Many horse and agricultural shows have classes for Dartmoors. The Breed Society holds three major shows: at Ripon in June, at Ascot in July, and at Bicton, Exeter, in August.

FAN-SHAPED SCALLOPS

Most people are familiar with the attractive fan-shaped shell of the scallop, but few are aware that this mollusc is the basis of a major British fishing industry.

Above: A feeding scallop, *Pecten maximus*, showing its eyes and rows of sensory tentacles. Behind these can be seen a membrane that encloses the scallop's body.

Right: Unlike some bivalve molluscs the scallop can swim actively for short distances. It achieves this by a form of jet propulsion in which the muscle controlling the two valves contracts, causing the shell to expel water and propel the scallop.

Below: When a scallop moves to a new site, it excavates a small crater for settling in, placing the rounded half of its shell downmost. Then it covers its top half with silt or sand to provide camouflage.

The scallop, or clam as it is sometimes known in Scotland, is a bivalve mollusc closely related to the oyster and the mussel. Also known as the giant scallop to distinguish it from the smaller queen scallop which belongs to a different genus, it is widely distributed in European waters from Norway to the Iberian Peninsula. It lives on the sea-bed at a range of depths, usually between 20m and 40m (10 to 20 fathoms).

The scallop lives in a variety of sea-bed habitats, from sand or mud to rocks or stones. It is mainly a coastal species and prefers water with a high salt level, which means that it is rarely found in estuaries with their perpetual supply of fresh water draining into the sea.

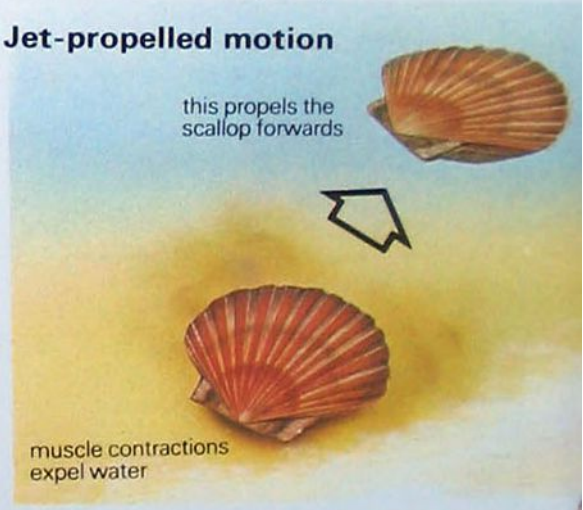
Shell motif The shell of a scallop is roughly saucer-shaped and consists of two halves called valves. The bottom valve is curved for nestling into the sea-bed; the top valve is flat. Each valve is sculptured with 15 to 17 ribs radiating from an edge. These ribs give the margin of the shell a characteristically crenulate (wavy) shape. The shape of a scallop is familiar to most people, for it forms the motif of a well-known petroleum company.

The edges of the two valves from which the ribs radiate are hinged together by a rubbery ligament. The valves are opened and closed by a large muscle, which is powerful enough to make the live animal difficult to open.

Inside the shell The organs of the scallop lie inside the shell and are enclosed in a thin membrane called the mantle. Around the edges of the mantle, along the shell edge, are rows of sensory tentacles and a number of bright eye spots. The tentacles are used to detect food and chemical changes, and for other purposes; the eye spots are believed to give the scallop some warning of the approach of predators or fishing gear.

The scallop feeds by drawing in water through a set of gills lying just inside the mantle. Cilia on the gills reject large particles and pass edible matter such as single-celled algae and detritus into the mouth.

Life-cycle The scallop is an hermaphrodite, having both male and female parts. When spawning occurs, sperm is normally released first by the scallop, followed several hours later by eggs. The sex products are simply ejected into the surrounding water where they fertilise either each other or the sperm or eggs released by nearby scallops – the spawning of one scallop can stimulate ripe individuals in the immediate vicinity to spawn.



Above: A commercial catch of scallops. The British scallop industry has expanded rapidly during the last decade, stimulated by the discovery of new grounds in the English Channel and Cardigan Bay. The annual scallop catch in Britain is now worth more than £4 million.

Below: Most scallops are caught by fishing boats using nets to dredge the sea floor, a method that unavoidably catches a wide range of other species.

Spawning usually takes place from April to September, though the actual timing varies around the coast of Britain and from year to year.

For the first three weeks of its life the scallop larva is free-living, partly swimming around erratically and partly being swept along by tides and currents. After three weeks, when the young larva is a mere $\frac{1}{4}$mm across, it settles on a suitable surface such as a seaweed or a hydroid, where it anchors itself by means of sticky threads called byssal threads. There the young scallop feeds and grows until it can develop a shell thick enough to withstand life on the sea-bed. Once it has done that, it settles on the sea-bed, hiding among stones and gravel.

The young scallop–which is called a spat in its first year–grows steadily and reaches maturity after three years. While still small the scallop is a favourite prey of various fishes such as plaice and turbot; crabs and starfishes also take their share. As it matures the risk of predators decreases and, provided it avoids getting caught by fishing, a mature scallop may well live to an age of 15 years or more and grow to be 15cm (6in) across.

Growth rings Like other molluscs, the scallop increases the size of its shell by adding to it each day a layer of calcium carbonate secreted by the mantle. These daily rings, or 'striae' as they are known, can be seen only under a microscope, but much more distinct rings are produced each year where the scallop ceases growth during the winter.

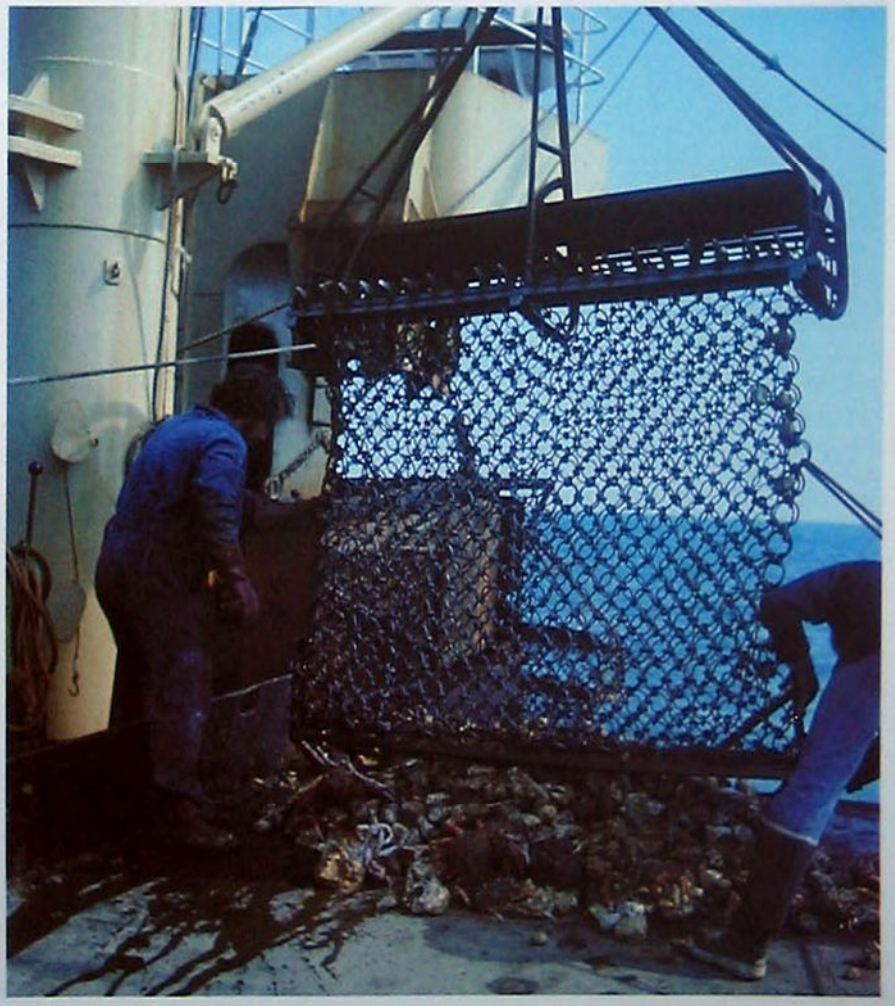
These annual rings can be used to find out the age of a scallop, which makes this mollusc one of the few in which accurate ageing is possible.

The scallop industry During the last few years commercial scallop fishing has increased dramatically, so that it is now a major part of the British fishing industry with an annual catch valued at more than £4 million.

Records show that scallops have been caught regularly for more than a hundred years. In Scottish waters the scallop industry began to expand during the 1930s, when stocks in the Clyde sea area started to be fished. Following that, new grounds were located up the west coast of Scotland and around Orkney and Shetland and in the Moray Firth.

In England, scallop fishing began to expand only during the 1970s, when extensive stocks were discovered in the English Channel. The scallop harvest from this area proved to be a bonanza for inshore fishermen, who were attracted by the large catches and a big demand for this succulent mollusc.

Scallop farming With the increase in scallop fishing our national stock of this mollusc is coming under increasing pressure and scientists are now looking at ways of maintaining production and the possibility of fishery management. This work could ultimately lead to the restocking of natural beds–a system widely used in Japan. But it is not yet known whether scallop farming would be economical around Britain.



OUR WILD WOODLAND APPLE TREE

The wild apple tree of woods and hedges is closely related to our cultivated apple trees, despite its small, 'crabby' sour-tasting fruits.

Apart from the northern half of Scotland, where it is rare or possibly even absent, the wild apple is found in broad-leaved woodland throughout the British Isles. Yet, although it is one of our few native trees, it is never very common and is rarely dominant in a wood. It is much more likely to be seen scattered as single trees or in small clumps through, typically, an oakwood. It can also be seen growing in hedgerows.

Shrub or tree Wild apple usually grows to be a small tree, forming part of the understorey of woodland, though it sometimes remains a shrub throughout its life. In woods where it competes for light with other trees it develops a narrow shape but, where space allows, it expands to form a full rounded outline, sometimes growing wider than it does high.

The trunk and branches of a wild apple are often crooked and the twigs twisted and intertwined. The bark is grey-brown, fissured and flaky when old, but is smooth and paler on young trees.

Cultivated relatives In its leaves, flowers and fruits, the wild apple bears a close resemblance to cultivated apple trees, all being members of the same genus, *Malus*.

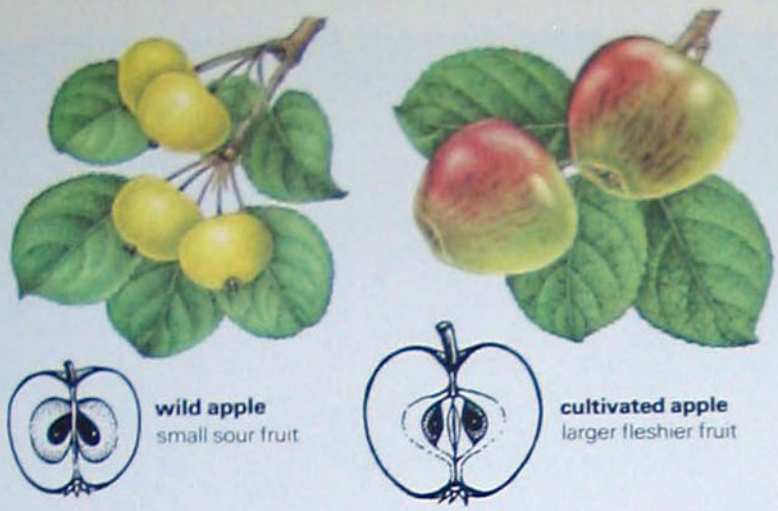
The leaves are similar in being toothed, oval and pointed, dark green above and paler below. They differ in being hairless when mature; the leaves of a cultivated apple tree are downy underneath. The two trees also differ in their shoots, those on a wild apple being thorny whereas those on a cultivated tree are usually thornless.

The flowers of a wild apple appear in late April, soon after the leaves have unfurled. Like the more familiar apple blossom in gardens, wild apple flowers have five petals and are white, tinged with pink. A few weeks after fertilisation the young fruits begin to develop, forming a swelling on the stem at the base of each flower.

Above: A wild apple in fruit. The twisted branches and broad squat shape are typical of a wild apple tree growing in the open.

Wild or **crab apple** (*Malus sylvestris*). Deciduous native found mainly in broad-leaved woodland, particularly oak woods. Height to 10m (33ft).

Right: Wild apple blossom appears in late April and is similar to cultivated apple blossoms.



Above: With its oval toothed leaves and its fruits, the wild apple is very similar to our familiar domestic apple trees. The most significant differences lie in the fruits themselves, wild apples being much smaller (about 2.5cm/1in across) and less fleshy.

When they ripen in September the apples, which have by then reached a size of 2.5cm (1in) in diameter, are green or yellow-green, sometimes flecked with red or more generally reddish. The fruits are much smaller than domestic apples and they are usually greener, but the most important difference lies in the taste. Wild apples have none of the sweetness of their cultivated counterparts; instead they are extremely sour–hence their common name of crab apples.

Food for wildlife Despite their taste, crab apples are a valuable source of food for wild animals. In a good year, a tree can bear hundreds of apples, which are eaten by birds and by mammals of all sizes from voles to deer. Similarly, the leaves are a welcome source of food for insects, caterpillars of the mottled umber and the winter moths in particular.

A familiar plant that feeds on apple trees is mistletoe. This parasitic plant grows on the branches, sending out tentacles called haustoria to penetrate the tree's bark and burrow into its tissues, absorbing water and nutrients. Mistletoe's original habitat was on wild apple trees growing in oak forests, and for this reason people came to associate mistletoe with oak trees, even though it rarely grows on them.

Apples and man We no longer eat crab apples, except in cooked forms, such as crab apple jelly. However, the discovery of apple remains at neolithic sites in Europe suggests that they were an important food for Stone Age man. Certainly, they were cultivated in the ancient civilisations of Egypt, China and Babylon; by 300BC the ancient Greeks were growing several named varieties of apples in their orchards. The Romans further developed the cultivation of apples and introduced them to other countries, including Britain.

With the spread of cultivated apple varieties our own native wild apple ceased to have much commercial importance, although it is still used as a rootstock on to which modern apple varieties are grafted.

The wood of a wild apple tree is hard and heavy, being slow-growing, and does not split easily. It can be used for making mallets, tool handles and rulers, and for turning and carving. The heartwood is reddish-brown, the sapwood paler.

An apple a day Man has long treated the apple tree with the greatest respect, regarding it as a magical tree. This is possibly because of its role as the tree of knowledge in the story of Adam and Eve, or because of its relation with mistletoe, another plant held in awe by our ancestors. The apple was a symbol of fruitfulness and rejuvenation. It was also held to be a charm against illness, a belief echoed today in the saying, 'An apple a day keeps the doctor away'. In a similar vein, the felling of an apple tree was held to be extremely ill-advised.

Above: Crab apples vary in colour from green or yellow-green to yellow, sometimes being flecked with red or more generally reddish in colour.

In medieval Britain ceremonies were held to help ensure a good apple crop every year. These ceremonies were of pagan origin and were held each January as a part of welcoming in the new year.

In other countries the apple has played an equally important role in folklore. Apples feature in many Greek, Roman and Scandinavian legends, and also in the Bible. However, we cannot always be sure that the fruit mentioned is an apple, since the word 'apple' in many ancient languages used to signify fruits in general. So the famous apple in the Garden of Eden could just as well have been an apricot, for example, or any other fruit.

SAND MARTINS: BUSY TUNNELLERS

Sand martins are summer visitors related to house martins and swallows. You almost always find them near sandy cliffs, soft river banks or sand quarries, for here they dig their long tunnels, often in colonies numbering hundreds of birds.

Above: The young birds move to the outer end of the nest tunnel, where they await the return of their foraging parents. The large hole seen below the nest tunnel is not the work of sand martins, but probably results from erosion. It could be occupied by larger birds such as jackdaws.

Sand martin (*Riparia riparia*); summer visitor; nests in colonies in sandy cliffs; brown, with no blue plumage; 12cm ($4\frac{3}{4}$in).

The sand martin, the house martin and the swallow are the only three members of the hirundine family of birds to be found regularly in the countryside of Britain and Ireland. Of these, the sand martin is the least well known; with its dull brown and white plumage, it appears at first sight to be the least interesting of the three. In fact it has a highly distinctive lifestyle, and its gregarious activities reward the birdwatcher with many memorable hours.

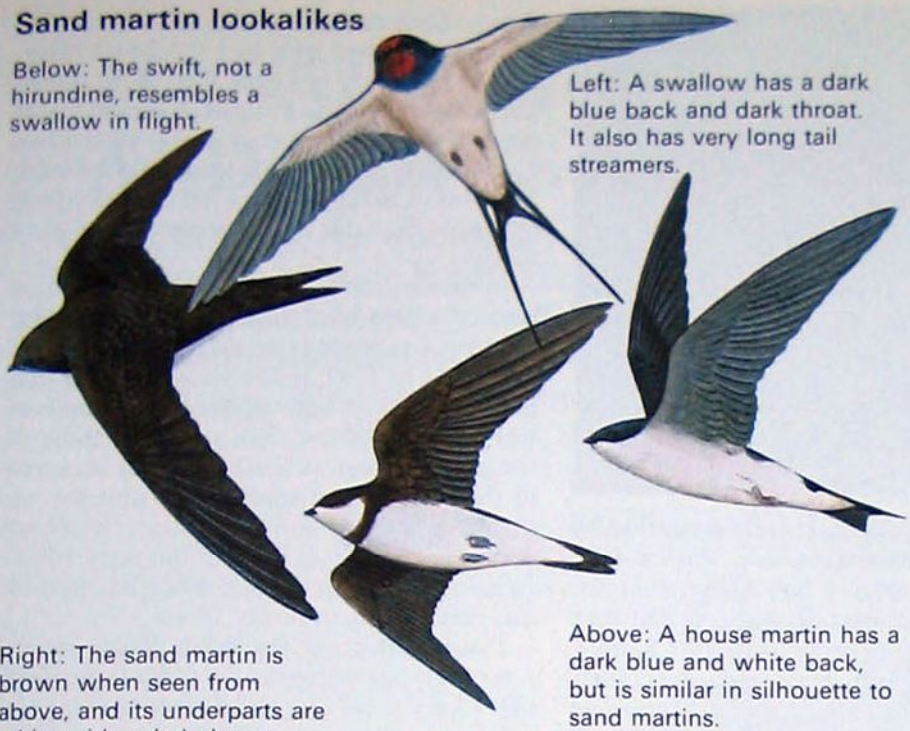
Distinctive brown plumage Sand martins lack the blue plumage of the house martin and swallow, and also lack the latter's long tail streamers. They are much smaller than their two relatives – about half the weight of a swallow and two-thirds that of a house martin. They feed aerially and, when seen in flight silhouette, are very like the house martin, but their brown plumage is altogether different and distinctive.

Winter conditions in Britain are, of course, impossible for hirundine birds, as all their flying insect food is missing. The sand martins are therefore with us only from late March or April through to September or early October. During the winter they are in West Africa, most of them probably in Senegal.

Unusual colonies The earliest birds to arrive are the adults of the previous year. They may be three or four weeks ahead of the young birds, and are certainly well ahead of the swallows and house martins. The first arrivals are generally found in small flocks feeding over water, where the insect life is likely to be concentrated. Soon, however, they start to visit their old colonies, for sand martins are colonial breeding birds, nesting in vertical sand banks in which they excavate long tunnels.

Colonies, in natural situations, are typically found in riverside banks where winter floods have washed away the bank in sandy ground, leaving a vertical face. Sandy cliffs at lake or sea side may also be used. However, in the south of England such natural sites are very unusual and by far the majority of colonies are in man-made sites – where sand or gravel is being excavated, or where other excavations

Sand martin lookalikes



Below: The swift, not a hirundine, resembles a swallow in flight.

Left: A swallow has a dark blue back and dark throat. It also has very long tail streamers.

Right: The sand martin is brown when seen from above, and its underparts are white with a dark throat.

Above: A house martin has a dark blue and white back, but is similar in silhouette to sand martins.

have taken place. These may include railway or road cuttings, foundation diggings for buildings, silage pits or even heaps of graded sand. Fine soil in chalk or clay pits may be used, and there are also records of birds breeding in heaps of sawdust, in rotten brickwork and down the drainage pipes in hard masonry walls.

When breeding begins in a colony, birds are stimulated by the breeding activity of their fellow members, and so groups of sand martins are found all making their preparations at the same time. The early birds, working almost in synchronised timing, begin to excavate nest holes.

The nest chamber, situated at the end of the tunnel and slightly above the entrance for good drainage, is lined with fine grasses and feathers, which the birds generally catch in the air or, sometimes, take from the ground. One of the most exciting times in a colony is when the birds engage in feather games–one bird drops a feather and the others compete to catch it as it falls down the cliff face–until one manages to gather it, and then uses it in its nest lining.

Life of the young birds The young birds, when they fledge, have a much softer plumage than their parents, with brown or russet fringes to many of their feathers. The youngsters are lively and even disruptive, dozens of them taking part in extensive feather games. Soon they may be joined by young birds from colonies far away, who have started to move about the countryside. These flocks of moving birds roost either in established colonies where there are enough vacant holes, or they descend on a reedbed–something they frequently do in flocks of thousands.

As the summer progresses, the time soon comes when all the first brood young have started to explore their surroundings. It is

Above: The clutch generally consists of five eggs (sometimes as few as three or as many as seven) and they are pure white. The eggs hatch after about two weeks and the young fledge some 18-20 days later. The very earliest nestlings, in a good year, fledge by the beginning of June, but in a well-populated colony, nesting is continuous until mid-August. The most successful pairs will by then have had three broods.

Right: This sand quarry has become the site of a moderate-sized colony of sand martins. Few successful colonies hold less than ten pairs of birds and, in years when the sand martin population is high, many colonies have hundreds of pairs.

Above: In flight, sand martins reveal that their white underparts are marked with a band across the breast, distinguishing them from house martins, which have completely white underparts. To the dedicated birdwatcher, sand martins are as much a sign of spring as swallows are the harbingers of summer, for they begin to arrive from their wintering grounds during March. All through summer they can be seen making long, curving flights across open spaces such as meadows or stretches of open water, catching the insects that fly in myriads in these locations.

not long before they start their migration by gradually heading southwards. Within Britain, large-scale ringing has shown that the birds move a little east of south so that they can make a short sea crossing of the Channel. The roosts in Sussex, Kent and particularly in the Fens of East Anglia are an impressive sight, for they can hold tens or even hundreds of thousands of birds. Once across the Channel, the birds' progress has been charted along the Biscay coast of France around Nantes, and thence down to Spain and the Mediterranean–probably via the Ebro Valley. The few records in Africa come mostly from Morocco and then, in the winter, from Senegal.

Disaster and recovery The wintering area of the sand martin was subjected to a very severe drought during the 1960s. This area is known as the Sahel and lies on the southern fringe of the Sahara; the climate there has always been rather dry, but a rainy season each year allowed trees and shrubs to thrive. In the summer of 1968 the rains failed altogether, causing a serious drought and altering the whole ecology of the area. Trees died, and the ground flora was badly reduced. This loss of foliage led to a fall in the amount of insect life, the food supply of the sand martin.

In Britain, the sand martin population had been at a high level through the early 1960s, but very few birds came back from Africa in the spring of 1969. It has been estimated that in the course of one winter, their numbers were reduced to less than a third of those of the previous year. A similar tragedy occurred in three other bird species: the whitethroat, the sedge warbler and the redstart, which all winter in the Sahel. Even in the early 1980s, Britain's sand martins are much less numerous than during the early 1960s.

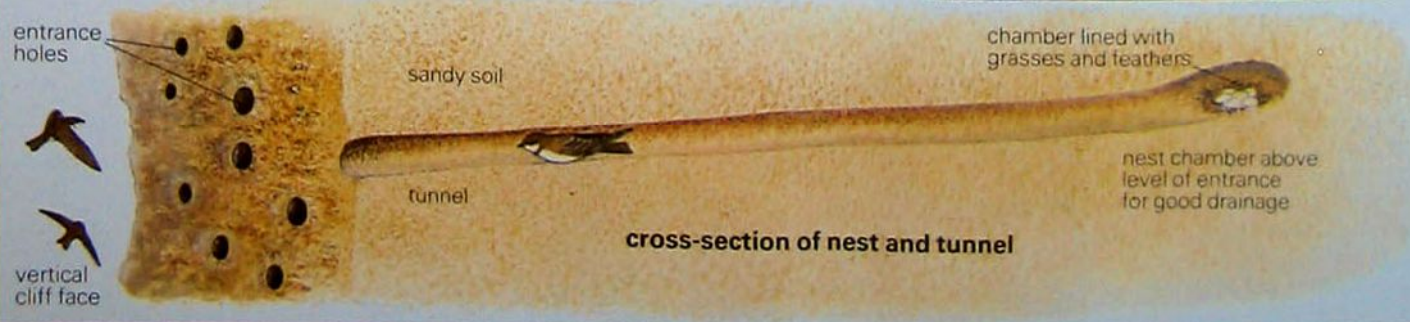
Communities on the cliffs Sand martin colonies house a community of bird and insect life. Many other species of birds breed in the holes–even little owls which may themselves catch and eat the sand martins. Tree sparrows, starlings and, in big old holes, jackdaws are probably the commonest guests of the sand martins. Many colonies are also regularly attacked by predators from outside–kestrels and sparrowhawks and sometimes even hobbies.

Besides predators, the community includes parasites, for the holes are a suitable habitat for certain species of fleas. Finally, crows, rooks and jackdaws occasionally join the community when they visit unoccupied holes to feed on the parasites.

The tunnel and its many tenants

The making of the tunnel The bird flutters and hovers at the face of the sand cliff and scratches with its feet, gradually starting the tunnel. As soon as the bird has a ledge on which to rest, it stands and kicks the sand backwards (right). It may take two or three weeks to complete the tunnel.

Fellow inmates Sand martins carry numerous parasites. These include the minute feather-lice and the larger louse-flies. There are also feather mites, tiny creatures that feed on feather debris. Blood-sucking flies such as *Crataerina hirundinis* (inset) are also found among the plumage of sand martins. These insects, which are sometimes also found on swallows, swifts and house martins, have stunted wings and cannot fly. Like fleas, they are able to survive winter in a dormant state until the return of the birds, whose movements and bodily warmth reawaken the flies.



cross-section of nest and tunnel

ARNSIDE WOODS AND CLIFFS WALK

A walk through the woodlands and along the sea cliffs around Arnside Knott (below) in Cumbria reveals magnificent views, varied scenery and a range of interesting wildlife that is a result of the area's underlying limestone rock and mild climate.

Arnside Knott, a well-wooded hill, rises to 159m (521ft) above sea level from the rocky cliffs and mudflats of the estuary of the River Kent in Cumbria. It is only just in Cumbria – the Lancashire border at Silverdale is only a kilometre (½ mile) away. The Knott is just outside the Lake District National Park but is included in the Arnside/Silverdale *Area of Outstanding Natural Beauty*; much of it is now owned by the National Trust.

The wildlife on and around the Knott is largely due to the underlying rock – carboniferous limestone, a hard, greyish-white rock formed in the warm seas of some 350 million years ago. Though most conspicuous in the coastal cliffs, limestone is also visible as out-

crops or screes in many other places, and accounts for the wide range of lime-loving species of trees and other plants, and the butterflies and moths whose larvae feed on them. Even snails are abundant, because limestone provides calcium carbonate for their shells; and the snails are preyed on by glow-worms whose brilliant greenish lights are a conspicuous feature of summer evenings on the Knott. Another important factor in the biological wealth of the district is the mild winter climate. Arnside is at, or near, the northern limit of many species of plants and insects.

Beginning the walk Our walk starts and finishes at the National Trust car park on the Knott. To reach this by car or on foot from Arnside promenade, follow Silverdale Road from the Albion Hotel then take the right-hand turn, marked Redhills, at the top of the village hill. Keep to the right at the first fork and left at the second. The road narrows to a bridleway (open to cars) as it enters National Trust property. On a clear day a breath-taking view of the Lake District mountains soon opens up on the right. The bridleway, locally known as Saul's Drive, leads into the well-screened car park. There is no access for cars beyond this point.

Above: The woods around Arnside are fortunate in still possessing a number of red squirrels which feed on pine and larch cones, and on the bounty of hazel nuts that they find in the woods on the lower slopes.

Rejoin Saul's Drive on foot and continue to the right. The bridleway is enclosed by trees, chiefly hazel at first, but there are many yews on the steeper slopes further on. In Cumbria the native red squirrel still survives, though it has been replaced over most of England by the American grey squirrel. In a fertile year hazel nuts are an important item in the squirrels' diet and many are stored for winter. The cones of pine and larch trees also provide food for squirrels, and yews give them valuable shelter and sites for their dreys.

Yews also help to support many species of birds. In autumn the female trees bear heavy crops of juicy red berries which are eaten voraciously by flocks of mistle-thrushes, blackbirds, fieldfares and redwings. The hard seeds pass through the birds' bodies undigested and form a litter under the trees.

Above: One reason for the abundance of such birds as fieldfares, redwings and mistle-thrushes around Arnside Knott is the presence of rich crops of yew berries. These birds eat the juicy outer part of the berries but the hard seeds pass through without being digested. The dropped seeds then become a source of food for finches and tits.

Right: Keep an eye open for the big nest-heaps of the wood ant in the coppiced woods near the clifftops. These nests can house many thousands of ants.

Bullfinches and greenfinches crush these seeds with their powerful beaks to reach the kernels, while great tits and marsh tits (but not blue or coal tits) hammer the seeds open on a branch, producing a loud tapping often mistakenly attributed to woodpeckers.

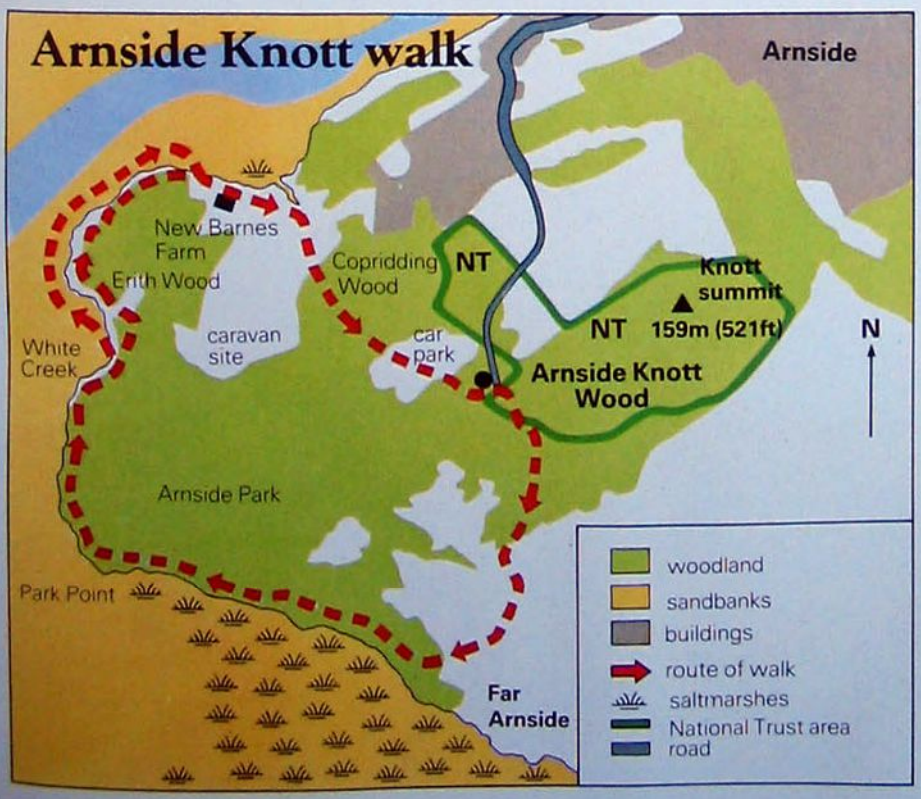
Along woodland and clifftop At the highest point of Saul's Drive turn to the right on to a footpath signposted to Far Arnside. A few years ago the open space on the left of the path was an enclosure occupied, and apparently devastated, by pigs, but the ground has now been re-colonized by varied vegetation, including several fine specimens of deadly nightshade.

Further on, the scrubby woodland on the right thins out into a hillside of blue moor grass dotted with typical plants of short limestone turf–including rockrose, tormentil, thyme and milkwort. At the foot of the hill follow signposts to Far Arnside until you reach a narrow metalled road. Turn right here, past a few houses, and follow the roadway through a caravan park to a public footpath into mixed woodland.

The path soon turns sharply down to the left towards the shore; signposts from here are marked White Creek and/or Arnside. This woodland was once coppiced and many stools of oak, ash and birch can be seen with a cluster of young trunks growing from them. The coppicing, carried out at intervals of about 15 years, used to support local industries, and also produced a temporary flush of rich ground flora, but the tree canopy is now too dense to permit a regular herb layer, except for a fine show of wild daffodils in March and April. However, the wood provides a refuge for roe deer (most often seen in early morning or late evening, singly or in family parties), foxes, occasional badgers and many smaller mammals. The huge teeming nest-heaps of the wood ant are also a conspicuous feature of these woods.

Above: You'll have to visit Arnside no later than March or April to see such a fine show of wild daffodils. They flourish early in the year, before the shade of the tree canopy has had time to blot out the light.

Below: This map shows the route of the walk around the Knott and along the cliffs. Watch out for high tides at White Creek and, if you stop for a picnic, please don't leave any litter.



As far as White Creek the path wanders from clifftop to woodland and back again. The clifftop stretches are particularly attractive, with short turf dotted with rockrose and harebell and rock whitebeam trees. These trees, recognisable by the silvery undersides to their leaves, grow out of crevices in the rock.

At Park Point the cliffs drop to a low ridge of limestone projecting into the estuary–an ideal site for a rest or a picnic. Shore birds are scarce in summer but shelduck and oystercatchers may still be seen round here.

Shingle and saltmarsh Further on, a conspicuous shingle bank, White Creek, comes into sight. Leave the wood here and follow the shingle bank, noting the strangely contorted wind-blown yews over a low stone wall on the right. Normally you should now keep to the shore, but high water on spring tides may reach the foot of a high vertical cliff for a few yards. If the high tide seems imminent, take the clifftop footpath instead.

The limestone cliffs here are darker and less weathered than those near Park Point. Two species of small fern–spleenwort and wall-rue–grow in their crevices. Relics of 19th century industry soon appear: the remains of a lime kiln and a quarry on the right, while on the left massive stone blocks and occasional iron rings mark the wharf, Blackstone Point, from which building stone was once exported to the Isle of Man. Fossils of corals and shellfish can be found near here, and heavy reddish stones may indicate a narrow vein of haematite iron ore.

From New Barns Farm follow the cart track to the left beside a small saltmarsh. On

Above: The limestone rock of Arnside provides the essential calcium carbonate for snails to form their shells. This specimen is a banded snail, and you can find many other species on your walk around the Knott.

Below: By way of contrast to the cliffs, the route of our walk descends to the flat estuarine saltmarshes of the River Kent. Look out for such birds as shelduck and oystercatcher here.

your right several flat arable fields indicate a former inlet of the estuary. After a hairpin bend take the footpath across a field towards the Knott and into Copridding Wood. In this wood there is a fine service tree and several small-leaved limes, both rare species this far north. A stony space on the right is covered with the distinctive leaves of lily-of-the-valley, a characteristic flower of limestone woodland.

Heathland The path leads up from the wood on to an attractive and interesting stretch of heathland. In summer luxuriant and colourful clumps of bell heather and ling show the presence of pockets of acid soil, perhaps left here by Ice Age glaciers, and among the heather are many creamy white burnet roses. Alder buckthorn, usually found in damp acid woods, is abundant on this dry stony hillside, but the lime-loving common buckthorn is also present.

Two beautiful limestone flowers on the heath are wild columbine, here a genuine native and not a garden escape, and dropwort, which differs from the related meadowsweet in its bigger, pink-tinged flowers and feathery leaves. The prolific growth of juniper, a local evergreen shrub increasingly scarce over most of Britain, is another surprise. Some specimens here are low and flat; others form 3m (10ft) high conical trees.

It is unfortunate that thickets of juniper and pine seedlings are encroaching on the open grassland, but the surviving flowers still attract a wide range of butterflies (including the Scotch argus) and moths, and the round, grassy hillocks of the yellow hill ant are visible in places. On these warm slopes you may find an occasional lizard or slow-worm, and on spring and summer evenings woodcock can be seen and heard 'roding' over the heath and adjoining woods, flying repeatedly over a chosen course while uttering a strange croaking call.

The footpath continues upwards, past a clump of Scots pines on the right, and shortly afterwards joins Saul's Drive at right angles. The car park is 90m (100yd) to the left of this junction.